TEXAS DEPARTMENT OF AGRICULTURE
COMMISSIONER SID MILLER

April 4, 2017

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Subject: Section 18 Emergency Specific Exemption for sulfoxaflor (Closer® SC Insecticide, EPA Reg. No. 62719-623) to manage the transmission of Huanglongbing (HLB) disease by controlling the Asian citrus psyllid (ACP) on citrus trees in commercial groves in Texas.

Dear Ms. Maignan:

The Texas Department of Agriculture (TDA) requests a specific exemption under the provisions of Section 18 of the Federal Insecticide, Fungicide and Rodenticide Act, as amended, for the use of sulfoxaflor (Closer® SC Insecticide, EPA Reg. No. 62719-623) to manage the transmission of Huanglongbing (HLB) disease by controlling the Asian citrus psyllid (ACP) on immature citrus trees in commercial groves in Texas.

This is the first year TDA has requested a specific exemption for this product. Dow AgroScience has been notified and supports the registration. Approval of Closer SC Insecticide for this use can save Texas citrus producers serious economic losses from tree destruction, fruit destruction and reduced yields. This disease can potentially destroy the Texas citrus industry if the insect vector is not properly controlled.

In 2012, HLB (also known as citrus greening disease) was first identified in Texas. This disease is caused by the pathogen *Candidatus Liberibacter asiaticus* and is spread by the ACP *(Diaphorina citri* Kuwayama), an invasive pest that was first discovered in Florida in 1998. HLB is considered the most serious disease of citrus worldwide and has greatly limited commercial production of citrus in countries where it is present. Since its discovery in Texas, this disease has spread throughout the citrus production area.

The requirements of 40 CFR 166.20(a,b) along with supporting information are attached for your review. We hope you will approve this application as soon as possible. Thank you for your attention to this serious problem.

This document was previously submitted to Ms. Tawanda Maignan and the EPA Section 18 Team on January 18, 2017 for comment. Texas has reviewed EPA's instructions and a page of additional support statements by Dr. Mamoudou Setamou has been added to this Specific Exemption Section 18 submission.

If you have any comments or questions regarding this submission, please contact Mr. Kevin Haack at 512-463-6982 or email: Kevin.Haack@TexasAgriculture.gov .

Sincerely,

Mr. Philip Wright
Administrator for Agriculture and Consumer Protection

PW/KH/kh

Additional Support Statements by Dr. Mamoudou Setamou (03.29.2017)

Need for emergency registration of Sulfoxaflor for psyllid control in Texas.

Dr. M Sétamou, Texas A&M University-Kingsville, Citrus Center
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Citrus greening disease also known as "huanglongbing (HLB)" is deadly bacterial disease and transmitted by the Asian citrus psyllid. Both the vector and the disease are currently affecting citrus production in Texas. The disease was first discovered in two adjacent groves in San Juan, Hidalgo Co. in South Texas in January 2012, but has since spread to over 10% of the 4,700 commercial citrus blocks. HLB is also affecting the abundant residential citrus trees present in South Texas. There is no known cure for the disease and planting of clean nursery trees and aggressive psyllid control are critical to reducing the spread of the disease. Texas citrus growers have been implementing since 2010 an aggressive psyllid control in the form of an area-wide management program where all growers coordinate three sprays and make on average five to six additional sprays on their own bringing the total number of sprays for psyllid control to a minimum of eight (8) per year.

Currently, the most effective classes of insecticides for psyllid have been organophosphate (mostly chlropyrifos), pyrethroid (mostly fenpropathrin and beta-cyfluthrin) and neonicotinoid (imidacloprid and thiamethoxam), and their overuse will lead to rapid resistance development. For each of these three classes of effective insecticides in our psyllid control program, we have a maximum allowable amount of insecticides we cannot exceed per year, thus putting additional burden and hardship to our psyllid control program. We recently obtained emergency registration for the netonicotinoid clothianidin to be used in young and non-bearing trees in addition to imidacloprid and thiamethoxam. But this leaves our over 25,000 acres mature groves without such option.

Why is sulfoxaflor needed?

Sulfoxaflor is a sulfoximine, a new insecticide class that has proven to highly effective for psyllid control. It has no cross resistance to other insecticides such as pyrethroids, neonicotinoids, organophosphates and carbamates. It is an effective tool that will assist our growers in their psyllid management program and fight against the deadly citrus greening disease.

Unlike insecticides in the pyrethroid, neonicotinoid and organophosphate classes that negatively affect bees, sulfoxaflor is known to be safer for bees and pollinators in general, ***thus making it an environmentally safer yet effective psyllid control option in Texas***.

In a recent past, our citrus growers used to have sulfaxaflor as an effective insecticide for psyllid and other sucking pest (aphids, whiteflies and scale insects) control. ***It has proven to be a good***

resistance management tool as it allowed for rotation of insecticides and prevented overuse of the same classes of insecticides in our groves.

Since sulfoxaflor is an entirely different class of insecticide with no known cross resistance to currently registered insecticides, growers could use in their mature groves for effective psyllid control. ***Registration of sufloxaflor will be beneficial for good pesticide stewardship for citrus pest management in Texas***.

Our growers DO NOT spray during bloom, thus further reducing the risks of exposure to pollinator of an already benign insecticide in sulfoxaflor.

We are urging EPA to favorably consider our request for an emergency registration of sulfoxaflor for psyllid control to reduce the spread of citrus greening disease in our groves.

2016 FIFRA SECTION 18

General information requirements of §40 CFR 166.20(a) in an application for a specific exemption.

TYPE OF EXEMPTION BEING REQUESTED

✓ SPECIFIC

QUARANTINE

PUBLIC HEALTH

SECTION 166.20(a)(1): IDENTITY OF CONTACT PERSONS

i. This application to the Administrator of the Environmental Protection Agency (EPA) for a specific exemption to authorize the use of Sulfoxaflor (Closer® SC Insecticide EPA Reg. No. 62719-623) to control the Asian Citrus Psyllid in mature commercial Citrus groves by the Texas Department of Agriculture. Any questions related to this request should be addressed to:

Kevin D. Haack
Coordinator for Pesticide Product Evaluation and Registration
Texas Department of Agriculture
P.O. Box 12847
Austin, TX 78711
Phone: (512) 463-6982
Kevin.Haack@TexasAgriculture.gov

ii. The following qualified experts are also available to answer questions:

University Representative:

Dr. Mamoudou Setamou
Citrus Entomologist
Texas A&M University-Kingsville Citrus Center
312 N. International Blvd.
Weslaco, TX 78599
Phone: 956-447-3370
Email: Mamoudou.Setamou@tamuk.edu

Registrant Representative:
Tami Jones-Jefferson
U.S. Regulatory Leader
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SECTION 166.20(a)(2): DESCRIPTION OF THE PESTICIDE REQUESTED

i. **Common Chemical Name (Active Ingredient):** Sulfoxaflor

Trade Name and EPA Reg. No.: Closer® SC Insecticide, EPA Reg. No. 62719-623

Formulation: Active Ingredient 21.8%

SECTION 166.20(a)(3): DESCRIPTION OF THE PROPOSED USE

i. **Sites to be treated:** Mature Commercial citrus groves are those located in 8 Texas counties (Brooks, Cameron, Hidalgo, Jim Hogg, Kenedy, Starr, Willacy, and Zapata).

ii. **Method of Application:** airblast sprayer delivering 50 - 250 gal. per acre mixture (water and concentrate) to mature citrus trees.

OR by air (crop sprayer plane) in a minimum of 3 gal. of mix per acre.

iii. **Rate of Application:** 2.75-5.75 fl oz / acre (0.043 – 0.09 lb. ai / acre)

iv. **Maximum Number of Applications:** 4 application per crop and total amount of Closer not exceeding 17 fl oz per acre per year.

v. **Total Acreage to be Treated:** There are approx. 27,000 acres of commercial Citrus groves in the 8 Texas counties affected by this Section 18.

vi. **Total Amount of Pesticide to be used:**

Maximum amount of product to be applied :

$$\frac{27{,}000 \text{ acres} \times 4 \text{ applications/crop} \times 5.75 \text{ fl oz/acre/application}}{128 \text{ fl oz / gallon}} = 4852 \text{ gallons}$$

vii. **Restrictions and Requirements:**

- **Preharvest Interval**: Do not apply within 1 day of harvest.
- Minimum Treatment Interval: Do not make applications less than 14 days apart.
- Do not make more than four applications per crop.
- Do not make more than two consecutive applications per crop.
- Do not apply more than a total of 17 fl oz of Closer SC (0.266 lb ai of sulfoxaflor) per acre per year.
- Only one application is allowed between 3 days before bloom and until after petal fall per year.
- A re-entry period (REI) of 12 h is required after application.

For this particular exemption request, the industry will follow a use pattern that completely avoids the major bloom period on Texas citrus.

viii. **Duration of the Proposed use:**

All year long except: The use of the insecticide will be **forbidden from 3 days prior to bloom until petal fall** (i.e. completion of bloom)

ix. **Earliest Possible Harvest Date:**

A pre-harvest interval (PHI) of 1 day (.i.e 24 h) is adequate for this class of insecticides.
However, a re-entry period (REI) of 12 h is required after application.

SECTION 166.20(a)(4): ALTERNATIVE METHODS OF CONTROL

Registered Alternative Pesticides: by Dr. Mamoudou Setamou

> "Currently the most effective insecticides for psyllid control include pyrethroids and neonicotnioids. Pyrethorids are broad spectrum insecticides that flare up many secondary pests such scale insects and spider mites due to their negative impacts on beneficial arthropods. Thus, growers resort mainly to the use of neonicotinoids (i.e. imidacloprid and thiamethoxam) for effective psyllid control in Texas. Given that all neonicotinoids have the same mode of action, there is a risk of resistance development to this class of insecticide that will ultimately be lost if no management plan is put in place. Given its high efficiency in psyllid control and low toxicity to natural enemies, Closer (sulfoxaflor) is a good alternative that could be used to effectively control psyllids and manage the risk of resistance development to neonicotinoid. In spite of sharing a target site with neonicotinoids (the nicotinic acetylcholine receptor), no cross-resistance is observed between sulfoxaflor and these neonicotinoids. This lack of cross-resistance indicates that sulfoxaflor is a valuable new tool for the management of psyllids in commercial groves in Texas."

SECTION 166.20(a)(5): EFFICACY OF USE PROPOSED UNDER SECTION 18

By Dr. Mamoudou Setamou

"Since 2009, Texas citrus growers have initiated the implementation of an area-wide control of the Asian citrus psyllid and this proactive psyllid control program has led to significant reductions of psyllid populations throughout the entire citrus production area. Effective psyllid control is achieved using several insecticides. Closer (a.i. sulfoxaflor) has proven to be efficacious in the control of psyllid populations as shown in the accompanying efficacy data for a trial conducted in 2013. We have tested Closer as a number compound before its first registration, and we continuously tested it and made recommendations for its use by growers when it became commercially available."

See EFFICACY DATA (Tab 6)

SECTION 166.20(a)(6): EXPECTED RESIDUES FOR FOOD USES

Michael Hare, Ph.D.

Acute Assessment

Food consumption information from the USDA 1994-1996 and 1998 Nationwide Continuing Surveys of Food Intake by Individuals (CSFII) and maximum residues from field trials rather than tolerance-level residue estimates were used. It was assumed that 100% of crops covered by the registration request are treated and maximum residue levels from field trials were used.

Drinking water. Two scenarios were modeled, use of sulfoxaflor on non-aquatic row and orchard crops and use of sulfoxaflor on watercress. For the non-aquatic crop scenario, based on the Pesticide Root Zone Model/Exposure Analysis Modeling System (PRZM/EXAMS) and Screening Concentration in Ground Water (SCI-GROW) models, the estimated drinking water concentrations (EDWCs) of sulfoxaflor for acute exposures are 26.4 ppb for surface water and 69.2 ppb for ground water. For chronic exposures, EDWCs are 13.5 ppb for surface water and 69.2 ppb for ground water. For chronic exposures for cancer assessments, EDWCs are 9.3 ppb for surface water and 69.2 ppb for ground water. For the watercress scenario, the EDWCs for surface water are 91.3 ppb after one application, 182.5 ppb after two applications and 273.8 ppb after three applications.

Dietary risk estimates using both sets of EDWCs are below levels of concern. The non-aquatic-crop EDWCs are more representative of the expected exposure profile for the majority of the population. Also, water concentration values are adjusted to take into account the source of the water; the relative amounts of parent sulfoxaflor, X11719474, and X11519540; and the relative liver toxicity of the metabolites as compared to the parent compound.

For acute dietary risk assessment of the general population, the groundwater EDWC is greater than the surface water EDWC and was used in the assessment. The residue profile in groundwater is 60.9 ppb X11719474 and 8.3 ppb X11519540 (totaling 69.2 ppb). Parent sulfoxaflor does not occur in groundwater. The regulatory toxicological endpoint is based on neurotoxicity.

For acute dietary risk assessment of females 13-49, the regulatory endpoint is attributable only to the parent compound; therefore, the surface water EDWC of 9.4 ppb was used for this assessment.

A tolerance of 3.6 ppm on dried citrus pulp and 0.7 ppm on the citrus crop group has been proposed. Assuming worst case scenario (100% crop treatment and all residues at tolerance levels) the acute dietary risk assessment for females 13-49 (the highest exposed population) would result in an increase in exposure of less than 2% of the aPAD over current acute dietary exposure assessments.

For this Section 18 request for use of sulfoxaflor on mature citrus, a tolerance of 3.6 ppm (citurs, dried pulp) has been established. In a previous acute and chronic aggregate dietary exposure and risk assessment (EPA DP #: 401670, September 12, 2012) to support a Section 3 registration for use on 39 individual crops, including many crop groups (including citrus), EPA concluded that all acute and chronic estimates were below levels of concern.

The acute dietary exposure from food and water to sulfoxaflor is 16% of the aPAD for children 1-2 years old and females 13-49 years old, the population groups receiving the greatest exposure. Approval of this section 18 request would likely increase acute dietary exposure, in a worst case scenario, of less than 2%.

Chronic Assessment

The same refinements as those used for the acute exposure assessment were used, except for the exception that average residue levels from crop field trials were used rather than maximum values. It was assumed that 100% of crops are treated and average residue levels from field trials were used.

For chronic dietary risk assessment, the toxicological endpoint is liver effects, for which it is possible to account for the relative toxicities of X11719474 and X11519540 as compared to sulfoxaflor. The groundwater EDWC is greater than the surface water EDWC. The residue profile in groundwater is 60.9 ppb X11719474 and 8.3 ppb X11519540. Adjusting for the relative toxicity results in 18.3 ppb equivalents of X11719474 and 83 ppb X11519540 (totaling 101.3 ppb). The adjusted groundwater EDWC is greater than the surface water EDWC (9.3 ppb) and was used to assess the chronic dietary exposure scenario.

The maximum dietary residue intake via consumption of citrus commodities would be only a small portion of the RfD (<0.1%) and therefore, should not cause any additional risk to humans via chronic dietary exposure. Consumption of citrus by sensitive sub-populations such as children and non-nursing infants would be less than 1% of the cPAD for the most sensitive population, children 1-2 years old. Thus, the risk of these subpopulations to chronic dietary exposure to sulfoxaflor used on citrus would be insignificant.

The major contributor to the risk was water (100%). The contribution of citrus to total dietary exposure was extremely low. All other populations under the chronic assessment show risk estimates that are below levels of concern.

Chronic exposure to sulfoxaflor from food and water is 18% of the cPAD for infants, the population group receiving the greatest exposure. There are no residential uses for sulfoxaflor.

Short-term risk. Because there is no short-term residential exposure and chronic dietary exposure has already been assessed, no further assessment of short-term risk is necessary, the chronic dietary risk assessment for evaluating short-term risk for sulfoxaflor is sufficient.

Intermediate-term risk. Intermediate-term risk is assessed based on intermediate-term residential exposure plus chronic dietary exposure. Because there is no residential exposure and chronic dietary exposure has already been assessed, no further assessment of intermediate-term risk is necessary.

Cumulative effects. Sulfoxaflor does not share a common mechanism of toxicity with any other substances, and does not produce a toxic metabolite produced by other substances. Thus, sulfoxaflor does not have a common mechanism of toxicity with other substances.

Cancer. A nonlinear RfD approach is appropriate for assessing cancer risk to sulfoxaflor. This approach will account for all chronic toxicity, including carcinogenicity that could result from exposure to sulfoxaflor. Chronic dietary risk estimates are below levels of concern; therefore, cancer risk is also below levels of concern.

There is a reasonable certainty that no harm will result to the general population, or to infants and children from aggregate exposure to sulfoxaflor as used in this emergency exemption request.

SECTION 166.20(a)(7): DISCUSSION OF RISK INFORMATION

Human Health Effects – Michael Hare, Ph.D.
Ecological Effects – Michael Hare, Ph.D.
Environmental Fate – David Villarreal, Ph.D.

Human Health Effects

Toxicological Profile

Sulfoxaflor is a member of a new class of insecticides, the sulfoximines. It is an activator of the nicotinic acetylcholine receptor (nAChR) in insects and, to a lesser degree, mammals. The nervous system and liver are the target organs, resulting in developmental toxicity and hepatotoxicity.

Developmental toxicity was observed in rats only. Sulfoxaflor produced skeletal abnormalities likely resulting from skeletal muscle contraction due to activation of the skeletal muscle nAChR in utero. Contraction of the diaphragm, also related to skeletal muscle nAChR activation, prevented normal breathing in neonates and increased mortality. The skeletal abnormalities occurred at high doses while decreased neonatal survival occurred at slightly lower levels.

Sulfoxaflor and its major metabolites produced liver weight and enzyme changes, and tumors in subchronic, chronic and short-term studies. Hepatotoxicity occurred at lower doses in long-term studies compared to short-term studies.

Reproductive effects included an increase in Leydig cell tumors which were not treatment related due to the lack of dose response, the lack of statistical significance for the combined tumors, and the high background rates for this tumor type in F344 rats. The primary effects on male reproductive organs are secondary to the loss of normal testicular function due to the size of the Leydig Cell adenomas. The secondary effects to the male reproductive organs are also not treatment related. It appears that rats are uniquely sensitive to these developmental effects and are unlikely to be relevant to humans.

Clinical indications of neurotoxicity were observed at the highest dose tested in the acute neurotoxicity study in rats. Decreased motor activity was also observed in the mid- and high-dose groups. Since the neurotoxicity was observed only at a very high dose and many of the effects are not consistent with the perturbation of the nicotinic receptor system, it is unlikely that these effects are due to activation of the nAChR.

Tumors have been observed in rat and mouse studies. In rats, there were significant increases in hepatocellular adenomas in the high-dose males. In mice, there were significant increases in hepatocellular adenomas and carcinomas in high dose males. In female mice, there was an increase in carcinomas at the high dose. Liver tumors in mice were treatment-related. Leydig cell tumors were also observed in the high-dose group of male rats, but were not related to treatment. There was also a significant increase in preputial gland tumors in male rats in the high-dose group. Given that the liver tumors are produced by a non-linear mechanism, the Leydig cell tumors were not treatment-related, and the preputial gland tumors only occurred at the high dose in one sex of one species, the evidence of carcinogenicity was weak.

Ecological Effects

Sulfoxaflor is systemically distributed in plants when applied. The chemical acts through both contact action and ingestion and provides both rapid knockdown (symptoms are typically observed within 1-2 hours of application) and residual control (generally provides from 7 to 21 days of residual control). Incident reports submitted to EPA since 1994 have been tracked via the Incident Data System. Over the 2012 growing season, a Section 18 emergency use was granted for application of sulfoxaflor to cotton in four states (MS, LA, AR, TN). No incident reports have been received in association with the use of sulfoxaflor in this situation.

Sulfoxaflor is classified as practically non-toxic on an acute exposure basis, with 96-h LC_{50} values of >400 mg a.i./L for all three freshwater fish species tested (bluegill, rainbow trout, and common carp). Mortality was 5% or less at the highest test treatments in each of these studies. Treatment-related sublethal effects included discoloration at the highest treatment concentration (100% of fish at 400 mg a.i./L for bluegill) and fish swimming on the bottom (1 fish at 400 mg a.i./L for rainbow trout). No other treatment-related sublethal effects were reported. For an estuarine/marine sheepshead minnow, sulfoxaflor was also practically non-toxic with an LC_{50} of 288 mg a.i./L. Sublethal effects included loss of equilibrium or lying on the bottom of aquaria at 200 and 400 mg a.i./L. The primary degradate of sulfoxaflor is also classified as practically non-toxic to rainbow trout on an acute exposure basis (96-h LC_{50} >500 mg a.i./L).

Adverse effects from chronic exposure to sulfoxaflor were examined with two fish species (fathead minnow and sheepshead minnow) during early life stage toxicity tests. For fathead minnow, the 30-d NOAEC is 5 mg a.i./L based on a 30% reduction in mean fish weight relative to controls at the next highest concentration (LOAEC=10 mg a.i./L). No statistically significant and/or treatment-related effects were reported for hatching success, fry survival and length. For sheepshead minnow, the 30-d NOAEC is 1.3 mg a.i./L based on a statistically significant reduction in mean length (3% relative to controls) at 2.5 mg a.i./L. No statistically significant and/or treatment-related effects were reported for hatching success, fry survival and mean weight.

The acute toxicity of sulfoxaflor was evaluated for one freshwater invertebrate species, the water flea and two saltwater species (mysid shrimp and Eastern oyster). For the water flea, the 48-h EC_{50} is >400 mg a.i./L, the highest concentration tested. For Eastern oyster, new shell growth was significantly reduced at 120 mg a.i./L (75% reduction relative to control). The 96-h EC_{50} for shell growth is 93 mg a.i./L. No mortality occurred at any test concentration. Mysid shrimp are the most acutely sensitive invertebrate species tested with sulfoxaflor based on water column only exposures, with a 96-h LC_{50} of 0.67 mg a.i./L. The primary degradate of sulfoxaflor is also classified as practically non-toxic to the water flea (EC_{50} >240 mg a.i./L).

The chronic effects of sulfoxaflor to the water flea were determined in a semi-static system over a period of 21 days to nominal concentrations of 6.25, 12.5, 25, 50 and 100 mg a.i./L. Adult mortality, reproduction rate (number of young), length of the surviving adults, and days to first brood were used to determine the toxicity endpoints. No treatment-related effects on adult mortality or adult length were observed. The reproduction rate and days to first brood were significantly ($p<0.05$) different in the 100 mg a.i./L test group (40% reduction in mean number of offspring; 35% increase in time to first brood). No significant effects were observed on survival, growth or reproduction at the lower test concentrations. The 21-day NOAEC and LOAEC were determined to be 50 and 100 mg a.i./L, respectively.

The chronic effects of sulfoxaflor to mysid shrimp were determined in a flow-through system over a period of 28 days to nominal concentrations of 0.063, 0.13, 0.25, 0.50 and 1.0 mg a.i./L. Mortality of parent (F_0) and first generation (F_1), reproduction rate of F_0 (number of young), length of the surviving F_0 and F_1, and days to first brood by F_0 were used to determine the toxicity endpoints. Complete F_0 mortality (100%) was observed at the highest test concentration of 1.0 mg a.i./L within 7 days; no treatment-related effects on F_0/F_1 mortality, F_0 reproduction rate, or F_0/F_1 length were observed at the lower test concentrations. The 28-day NOAEC and LOAEC were determined to be 0.11 mg and 0.25 mg a.i./L, respectively.

Sulfoxaflor exhibited relatively low toxicity to aquatic non-vascular plants. The most sensitive aquatic nonvascular plant is the freshwater diatom with a 96-h EC_{50} of 81.2 mg a.i./L. Similarly, sulfoxaflor was not toxic to the freshwater vascular aquatic plant, *Lemna gibba*, up to the limit amount, as indicated by a 7-d EC_{50} for frond count, dry weight and growth rate of >100 mg a.i./L with no significant adverse effects on these endpoints observed at any treatment concentration.

Based on an acute oral LD_{50} of 676 mg a.i./kg bw for bobwhite quail, sulfoxaflor is considered slightly toxic to birds on an acute oral exposure basis. On a subacute, dietary exposure basis, sulfoxaflor is classified as practically nontoxic to birds, with 5-d LC_{50} values of >5620 mg/kg-diet for mallard ducks and bobwhite quail. The NOAEL from these studies is 5620 mg/kg-diet as no treatment related mortality of sublethal effects were observed at any treatment. Similarly, the primary degradate is classified as practically nontoxic to birds on an acute oral exposure basis with a LD_{50} of >2250 mg a.i./kg bw. In two chronic, avian reproductive toxicity studies, the 20-week NOAELs ranged from 200 mg/kg-diet (mallard, highest concentration tested) to 1000 mg/kg-diet (bobwhite quail, highest concentration tested). No treatment-related adverse effects were observed at any test treatment in these studies.

For bees, sulfoxaflor is classified as very highly toxic with acute oral and contact LD_{50} values of 0.05 and 0.13 μg a.i./bee, respectively, for adult honey bees. For larvae, a 7-d oral LD_{50} of >0.2 μg a.i./bee was determined (45% mortality occurred at the highest treatment of 0.2 μg a.i./bee). The primary metabolite of sulfoxaflor is practically non-toxic to the honey bee. This lack of toxicity is consistent with the cyano-substituted neonicotinoids where similar cleavage of the cyanide group appears to eliminate their insecticidal activity. The acute oral toxicity of sulfoxaflor to adult bumble bees (*Bombus terrestris*) is similar to the honey bee; whereas its acute contact toxicity is about 20X less toxic for the bumble bee. Sulfoxaflor did not demonstrate substantial residual toxicity to honey bees exposed via treated and aged alfalfa (i.e., mortality was <15% at maximum application rates).

At the application rates used, the direct effects of sulfoxaflor on adult forager bee mortality, flight activity and the occurrence of behavioral abnormalities is relatively short-lived, lasting 3 days or less. Direct effects are considered those that result directly from interception of spray droplets or dermal contact with foliar residues. The direct effect of sulfoxaflor on these measures at the maximum application rate in the US is presently not known. When compared to control hives, the effect of sulfoxaflor on honey bee colony strength when applied at rates approximate to the proposed section 18 rate was not apparent in most cases. When compared to hives prior to pesticide application, sulfoxaflor applied to cotton foliage up to the maximum rate proposed in the US resulted in no discernible decline in mean colony strength by 17 days after the first application. Longer-term results were not available from this study nor were concurrent controls included. For managed bees, the primary exposure routes of concern include direct contact with spray droplets, dermal contact with foliar residues, and ingestion through consumption of contaminated pollen, nectar and associated processed food provisions. Exposure of hive bees via contaminated wax is also possible. Exposure of bees through contaminated drinking water is not expected to be nearly as important as exposure through direct contact or pollen and nectar.

In summary, sulfoxaflor is slightly toxic to practically non-toxic to fish and freshwater water aquatic invertebrates on an acute exposure basis. It is also practically non-toxic to aquatic plants (vascular and non-vascular). Sulfoxaflor is highly toxic to saltwater invertebrates on an acute exposure basis. The high toxicity of sulfoxaflor to mysid shrimp and benthic aquatic insects relative to the water flea is consistent with the toxicity profile of other insecticides with similar MOAs. For birds and mammals, sulfoxaflor is classified as moderately toxic to practically non-toxic on an acute exposure basis. The threshold for chronic toxicity (NOAEL) to birds is 200 ppm and that for mammals is 100 ppm in the diet. Sulfoxaflor did not exhibit deleterious effects to terrestrial plants at or above its proposed maximum application rates.

For bees, sulfoxaflor is classified as very highly toxic. However, if this insecticide is strictly used as directed on the Section 18 supplemental label, no significant adverse effects are expected to Texas wildlife. Of course, standard precautions to avoid drift and runoff to waterways of the state are warranted. As stated on the Section 3 label, risk to managed bees and native pollinators from contact with pesticide spray or residues can be minimized when applications are made before 7 am or after 7 pm or when the temperature is below 55°F at the site of application.

Environmental Fate

Sulfoxaflor is a systemic insecticide which displays translaminar movement when applied to foliage. Movement of sulfoxaflor within the plant follows the direction of water transport within the organism (i.e., xylem mobile) as indicated by phosphor translocation studies in several plants. Sulfoxaflor is characterized by a water solubility ranging from 550 to 1,380 ppm. It has a low potential for volatilization from dry and wet surfaces (vapor pressure= 1.9 x 10^{-8} torr and Henry's Law constant= 1.2 x 10^{-11} atm m^3 $mole^{-1}$, respectively at 25 °C). Partitioning coefficient of sulfoxaflor from octanol to water (K_{ow} @ 20 C & pH 7= 6; Log K_{ow} = 0.802) suggests low potential for bioaccumulation. No fish bioconcentration study was provided by the manufacturer due to the low K_{ow}, but sulfoxaflor is not expected to bioaccumulate in aquatic systems. Furthermore, sulfoxaflor is not expected to partition into the sediment due to low K_{oc} (7-74 mL/g).

Registrant's tests indicate that hydrolysis, and both aqueous and soil photolysis are not expected to be important in sulfoxaflor dissipation in the natural environment. In a hydrolysis study, the parent was shown to be stable in acidic/neutral/alkaline sterilized aqueous buffered solutions (pH values of 5, 7 and 9). In addition, parent chemical as well as its major degradate, were shown to degrade relatively slowly by aqueous photolysis in sterile and natural pond water ($t_{½}$= 261 to >1,000 days). Furthermore, this insecticide was stable to photolysis on soil surfaces. Sulfoxaflor is expected to biodegrade rapidly in aerobic soil (half-lives <1 day). Under aerobic aquatic conditions, biodegradation proceeded at a more moderate rate with half-lives ranging from 37 to 88 days. Under anaerobic soil conditions, the parent compound was metabolized with half-lives of 113 to 120 days while under anaerobic aquatic conditions the chemical was more persistent with half-lives of 103 to 382 days. In contrast to its short-lived parent, the major degradate is expected to be more persistent than its parent in aerobic/anaerobic aquatic systems and some aerobic soils. In other soils, less persistence is expected due to mineralization to CO_2 or the formation of other minor degradates.

In field studies, sulfoxaflor has shown similar vulnerability to aerobic biodegradation in nine out of ten terrestrial field dissipation studies on bare-ground/cropped plots (half-lives were <2 days in nine cropped/bare soils in CA, FL, ND, ON and TX and was 8 days in one bare ground soil in TX). The chemical can be characterized by very high to high mobility (Kf_{oc} ranged from 11-72 mL g^{-1}). Rapid soil degradation is expected to limit chemical amounts that may potentially leach and contaminate ground water. Contamination of groundwater by sulfoxaflor will only be expected when excessive rain occurs within a short period (few days) of multiple applications in vulnerable sandy soils. Contamination of surface water by sulfoxaflor is expected to be mainly related to drift and very little due to run-off. This is because drifted sulfoxaflor that reaches aquatic systems is expected to persist while that reaching the soil system is expected to degrade quickly with slight chance for it to run-off.

When sulfoxaflor is applied foliarly on growing crops it is intercepted by the crop canopy. Data presented above appear to indicate that sulfoxaflor enters the plant and is incorporated in the plant foliage with only limited degradation. It appears that this is the main source of the insecticide sulfoxaflor that would kill sap sucking insects. This is because washed-off sulfoxaflor, that reaches the soil system, is expected to degrade.

In summary, sulfoxaflor has a low potential for volatilization from dry and wet surfaces. This chemical is characterized by relatively higher water solubility. Partitioning coefficient of sulfoxaflor from octanol to water suggests low potential for bioaccumulation in aquatic organisms such as fish. Sulfoxaflor is resistant to hydrolysis and photolysis but transforms quickly in soils. In contrast, sulfoxaflor reaching aquatic systems by drift is expected to degrade rather slowly. Partitioning of sulfoxaflor to air is not expected to be important due to the low vapor pressure and Henry's Law constant for sulfoxaflor. Exposure in surface water results from drifted parent as only minor amounts is expected to run-off only when rainfall and/or irrigation immediately follow application. The use of this insecticide is not expected to significantly adversely impact Texas ecosystems with use according to the Section 18 label with this application. Of course, caution is needed to prevent exposure to water systems because of toxicity issues to aquatic invertebrates. Drift as discussed in the ecotoxicity portion of this application is also a significant issue for bees and other pollinators and must be extremely minimized. As stated on the Section 3 label, this product should never be applied directly to water, to areas where surface water is present or to intertidal areas below the mean water mark. Do not contaminate water when disposing of equipment rinsates.

ENDANGERED AND THREATENED SPECIES IN TEXAS

by David T. Villarreal, Ph.D

No impacts are expected on endangered and threatened species by this very limited use of this insecticide in eight south most Texas counties as delineated in the Section 18 application. Sulfoxaflor demonstrates a very favorable fate profile as stated above and should not directly impact any protected mammal, fish, avian, or plant species. This product does adversely affect insects and aquatic invertebrates, especially bees, but the limited exposure to these species should not negatively affect endangered and threatened species in Texas. As always, the label precautions need be strictly adhered to in order to minimize environmental issues.

SECTION 166.20(a)(8): COORDINATION WITH OTHER AFFECTED STATE OR FEDERAL AGENCIES

The following state/federal agencies were notified of the Texas Department of Agriculture's (TDA's) actions to submit an application for a specific exemption to EPA

- Texas Commission on Environmental Quality (TCEQ), Air Quality Control
- Texas Commission on Environmental Quality (TCEQ), Water Quality
- Texas Parks and Wildlife Department
- U.S. Fish and Wildlife Department

SECTION 166.20(a)(9): ACKNOWLEDGEMENT BY THE REGISTRANT

Dow AgroScience has been notified of this agency's intent regarding this application (see attached letter of support). They have also provided a copy of a label with the use directions for this use (although this use is dependent upon the approval of this section-18 by EPA).

SECTION 166.20(a)(10): DESCRIPTION OF PROPOSED ENFORCEMENT PROGRAM

The State Legislature has endowed TDA with the authority to regulate the distribution, storage, sale, use and disposal of pesticides in the state of Texas. In addition, the EPA/TDA grant enforcement agreement provides the Department with the authority to enforce the provisions of the FIFRA, as amended, within the state. Therefore, the Department is no lacking in authority to enforce the provisions of an EPA Pesticide Enforcement Specialist will make a number of random, unannounced calls on applicators to check for compliance with provisions of the specific exemption. If violations are discovered appropriate enforcement will be taken.

SECTION 166.20(a)(11): REPEAT USES

This is the first time TDA has applied for this specific exemption.

SECTION 166.20(b)(1): NAME OF THE PEST

Asian Citrus Psyllid, (*Diaphorina citri* Kuwayama)

SECTION 166.20(b)(2): DISCUSSION OF EVENTS OR CIRCUMSTANCES WHICH BROUGHT ABOUT THE EMERGENCY SITUATION

In 2012, HLB (also known as citrus greening disease) was first identified in Texas. This disease is caused by the pathogen *Candidatus Liberibacter asiaticus* and is spread by the ACP *(Diaphorina citri* Kuwayama), an invasive pest that was first discovered in Florida in 1998. HLB is considered the most serious disease of citrus worldwide and has greatly limited commercial production of citrus in countries where it is present. Since its discovery in Texas, this disease has spread throughout the citrus production area.

SECTION 166.20(b)(3): DISCUSSION OF ANTICIPATED RISKS TO ENDANGERED OR THREATENED SPECIES, BENIFICIAL ORGANISMS, OR THE ENVIRONMENT

Endangered and Threatened Species in Texas

No impacts are expected on endangered and threatened species by this very limited use of this insecticide in eight south most Texas counties as delineated in the Section 18 application. Sulfoxaflor demonstrates a very favorable fate profile as stated above and should not directly impact any protected mammal, fish, avian, or plant species. This product does adversely affect insects and aquatic invertebrates, especially bees, but the limited exposure to these species should not negatively affect endangered and threatened species in Texas. As always, the label precautions need be strictly adhered to in order to minimize environmental issues.

As discussed previously, it is not anticipated that there should be any anticipated risks to endangered or threatened species, beneficial organisms or the environment if the application is made according to the section 18 use directions.

SECTION 166.20(b)(4): DISCUSSION OF SIGNIFICANT ECONOMIC LOSS

Texas is a significant producer of citrus products in the US. Texas is the third largest US producer of Citrus, behind Florida and California.

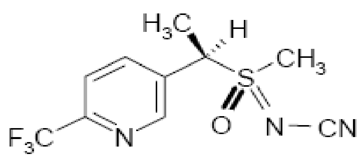
Economic losses of over 50% have occurred in Florida due to HLB. In unprotected Florida groves infestation levels are often above 50%. These economic losses have Texas Citrus Growers concerned. Texas growers fully support this Section 18 request to prevent these significant losses to Texas Citrus.

In 2007, The Center for North American Studies, CNAS, conducted an economic impact study of Citrus Greening on the Texas Citrus Industry [See **Economic Impacts of Greening on Texas Citrus Industry - CNAS Issue brief 2007-1** article located in MISCELLANEOUS (Tab 8) of this submission]. A 20% reduction in Citrus Production Value was projected after 2 years of infestation without adequate control measures. And a 60% reduction in Citrus Production Value was projected after 5 years. “These potential economic impacts on the Texas citrus industry represent what could occur if greening emerges and is not controlled and eventually eliminated. Greening can result in the complete loss of citrus trees and associated acreage resulting in loss of specialized infrastructure and leading to the decline of the entire industry. If this occurs, the economic impacts would be more severe, leading to greater losses in business activity, income and employment.”

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY AND
POLLUTION PREVENTION

Environmental Fate and Ecological Risk Assessment for Sulfoxaflor Registration



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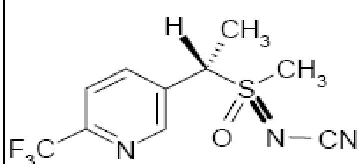

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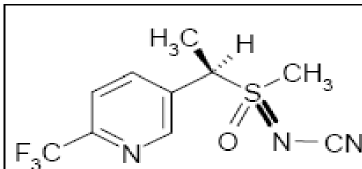
Diastereomer 1
X11546257



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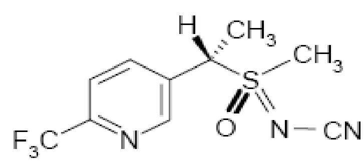

[(*S*)-1-(6-trifluoromethylpyridin-3-yl)ethyl]-(*R*)-(methyl)oxido-λ^4-sulfanylidenecyanamide (Enantiomer B1 X11861620)

Diastereomer 2
X11546258

Sulfoxaflor: A 50:50 Mixture of Diastereomer 1 and 2

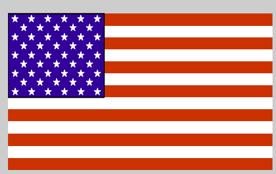

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Table of Contents

Table of Figures

Table of Tables

VI. Appendices

1. Executive Summary

1.1. Nature of Chemical Stressor

Sulfoxaflor (N-[methyloxido[1-[6-(trifluoromethyl)-3-pyridinyl]ethyl]-lambda 4-sulfanylidene]) is a new class of insecticide and is currently the only member of the sulfoxamine subclass of neonicotinoid insecticides.[1] It is considered an agonist of the nicotinic acetylcholine receptor (nAChR) and exhibits excitatory responses including tremors, followed by paralysis and mortality in target insects. In laboratory experiments, sulfoxaflor has been highly efficacious against target insects that display resistance to neonicotinoids such as imidacloprid, which is classified by the Insect Resistance Action Committee (IRAC) as subclass 4A. Sulfoxaflor consists of two diastereomers in a ratio of approximately 50:50 with each diastereomer consisting of two enantiomers.

Sulfoxaflor is formulated as suspensions concentrate and water dispersible granules and is proposed for application as a liquid spray on a variety of crops. The proposed crops include beans, berries, canola, citrus, cotton, fruits (pome/stone), ornamentals, grains "small", soybeans, tree nuts, turf, vegetables (brassica "leafy" bulb, cucurbits, fruity including okra, leafy, and root & tuber) and watercress. Sulfoxaflor is systemically distributed in plants. The chemical acts through both contact action and ingestion and provides both rapid knockdown (symptoms are typically observed within 1-2 hours of application) and residual control (generally provides from 7 to 21 days of residual control).

Transformation products of sulfoxaflor in the environment include: X11719474 (X-474; "major to dominant"), X11579540 (X-540; "minor to major"), and X11579457 (X-457; "minor"). Following consideration of exposure and toxicity for the residues of interest (that is parent, X-474 and X-540), the stressor of concern is defined as follows:

(1) For aquatic organisms: parent sulfoxaflor plus its degradate, X-540; and

(2) For terrestrial organisms: parent sulfoxaflor only.

With the exception of X-474, this assignment of stressors of concern for ecological risk is consistent with the risk assessment approach used by the Health Effects Division for sulfoxaflor (D396249). For terrestrial and aquatic ecological receptors, available evidence indicates that the X-474 degradate does not share the same MOA as the parent and is much less toxic based on measures of effect relevant to ecological risk assessment. Detailed data and information concerning this decision are presented in the problem formulation section of this document.

[1] http://www.irac-online.org/eClassification/

1.2 Potential Risks to Non-target Organisms

Table 1 provides a summary of the environmental risk conclusions for aquatic and terrestrial organisms, based on risk quotient (RQ) values and whether they exceed levels of concern (LOCs) for Federally-listed threatened and endangered species (hereafter referred to as "listed" species) and non-listed species.

Table 1. Summary of Ecological Risk Conclusions for the Proposed Sulfoxaflor Uses*

Taxonomic Group	Summarized Risk Characterization and Major Uncertainties
Fish and Aquatic Invertebrates (freshwater and saltwater)	The potential for acute or chronic risk is considered low, as acute or chronic RQ values do not exceed the risk to listed species LOC of 0.05.
Aquatic and Terrestrial Plants	The potential for risk is considered low, as RQ values do not exceed the LOC values for listed and non-listed aquatic or terrestrial plants.
Birds**	A potential for acute risk to birds is identified. Specifically, acute, dose-based RQ values calculated using a refined dissipation half-life (DT_{50}) exceed the risk to listed species LOC of 0.1 for at least one avian dietary category and size class across all uses. This risk finding is uncertain because the acute toxicity endpoint used to derive the avian RQ values represents a "non-definitive" endpoint and is based on a threshold for treatment-related increases in regurgitation. Acute and chronic diet-based RQ do not exceed applicable LOCs.
Mammals	A potential for chronic risk to mammals is identified. Specifically, chronic dose-based RQ values up to **3.8** were determined using a refined DT_{50} and exceed the risk to listed species LOC of 0.1 for at least one mammalian dietary category and size class across all uses. For some crops, information from residue-decline trials indicates relatively short half lives (*e.g.*, a few days), particularly on foliage. For these crops, there is uncertainty regarding whether the relatively short duration of exposure expected in the field would elicit similar reproductive effects as the chronic, 2-generation study with the rat where animals are fed treated diets continuously.
Bees	A potential for risk to honey bees is identified based on Tier 1 assessment results. Tier 1 acute oral RQ values range from <**0.8 to 5.7** across all larval and adult castes examined. Results from Tier 2 semi-field studies indicate direct effects of sulfoxaflor on adult foragers is likely to be short-lived at application rates of 3-67% of the single maximum rate proposed for the US. These studies were unable to preclude risk to developing brood or long-term colony health from the proposed sulfoxaflor applications due to limitations associated with their design and conduct.
* includes: Citrus, Fruits-Pome, Fruits-Stone, Ornamentals, Tree nuts, Turf grass; (Beans, Berries, Soybeans, Veg.-Brassica, Veg.-Bulb, Veg.-Leafy, Veg.-Root/Tuber, Veg.-Fruiting, Veg.-Cucurbit, Watercress, Cotton, Canola and Grains ** In absence of data, birds are used as a surrogate for terrestrial phase amphibians and reptiles.	

1.3 Conclusions - Exposure Characterization

Sulfoxaflor has a low potential for volatilization from dry and wet surfaces (vapor pressure= 1.9 x 10^{-8} torr and Henry's Law constant= 1.2 x 10^{-11} atm m^3 $mole^{-1}$, respectively at 25 °C). The chemical is characterized by a water solubility ranging from 550 to 1,380 ppm. Partitioning coefficient of sulfoxaflor from octanol to water (K_{ow}= 6) suggests low potential for bioaccumulation in aquatic organisms such as fish.

Sulfoxaflor reaching the soil system is subjected to rapid aerobic bio-degradation ($t_{½}$ <1 day) while that reaching foliage may enter the plant tissue and persist much longer. Sulfoxaflor has shown to be stable to hydrolysis/ photolysis on soil and in aquatic environments. In field studies, sulfoxaflor has shown similar vulnerability to aerobic bio-degradation in nine out of ten terrestrial field dissipation studies on bare-ground/cropped plots (half-lives were <2 days in nine cropped/bare soils in CA, FL, ND, ON and TX and was 8 days in one bare ground soil in TX).

The chemical can be characterized by very high to high mobility (K_{foc} ranged from 11-72 mL g^{-1}). Rapid soil degradation is expected to limit chemical amounts that may potentially leach and contaminate ground water. Contamination of groundwater by sulfoxaflor will only be expected when excessive rain occurs within a short period (few days) of multiple applications in vulnerable sandy soils. Contamination of surface water by sulfoxaflor is expected to be mainly related to drift and very little due to run-off. This is because drifted sulfoxaflor that reaches aquatic systems is expected to persist while that reaching the soil system is expected to degrade quickly with slight chance for it to run-off.

In contrast to sulfoxaflor parent, the major degradate X-474 and two other degradates (X-540 and X-457) are expected to be highly persistent in aerobic soil/aquatic systems. Adsorption data for these degradates indicate that they can be characterized by very high to high mobility for X-474 (K_{foc} ranged from 7-68 mL g^{-1}) and very high mobility for X-457 and X-540 (K_{foc} ranged from 2-44 mL g^{-1} for X-457 and K_{foc} ranged from 1-25 mL g^{-1} for X-540). Both surface and ground water contamination is expected from these three degradates following leaching drift/run-off events. The major degradate X-474 is expected to dominate the exposure resulting from use of sulfoxaflor.

1.4 Conclusions - Effects Characterization

Based on available data, sulfoxaflor is slightly toxic to practically non-toxic to fish and freshwater water column dwelling aquatic invertebrates on an acute exposure basis. It is also practically non-toxic to aquatic plants (vascular and non-vascular). Sulfoxaflor is highly toxic to saltwater invertebrates (mysid shrimp; *Americamysis bahia*) on an acute exposure basis. The NOAEC for chronic toxicity of sulfoxaflor to freshwater benthic insects (midge, *Chironomus riparius*) is 0.037 mg a.i./L in porewater. The high toxicity of sulfoxaflor to mysid shrimp and benthic aquatic insects relative to the water flea (*Daphnia magna*) is consistent with the toxicity profile of other insecticides with similar MOAs on the insect nAChR such as neonicotinoid insecticides.

For birds and mammals, sulfoxaflor is classified as moderately toxic to practically non-toxic on an acute exposure basis. The threshold for chronic toxicity (NOAEL) to birds is 200 ppm and that for mammals is 100 ppm in the diet. Sulfoxaflor did not exhibit deleterious effects to terrestrial plants at or above its proposed maximum application rates.

For bees, sulfoxaflor is classified as very highly toxic with acute oral and contact LD_{50} values of 0.05 and 0.13 µg a.i./bee, respectively, for adult honey bees (*Apis mellifera*). For larvae, a 7-d oral LD_{50} of >0.2 µg a.i./bee was determined (45% mortality occurred at the highest treatment of 0.2 µg a.i./bee). Its primary metabolite (X-474) is practically non-toxic to the honey bee. This lack of toxicity is consistent with the cyano-substituted neonicotinoids where similar cleavage of the cyanide group appears to eliminate their insecticidal activity. The acute oral toxicity of sulfoxaflor to adult bumble bees (*Bombus terrestris*) is similar to the honey bee; whereas its acute contact toxicity is about 20X less toxic for the bumble bee. Sulfoxaflor did not demonstrate substantial residual toxicity to honey bees exposed via treated and aged alfalfa (*i.e.*, mortality was $\leq$15% at maximum application rates).

A detailed analysis of six available Tier 2 semi-field (tunnel) studies was conducted in order to confirm or refute the risks identified from the Tier 1 assessment on honey bees. Five of the six semi-field studies used application rates ranging from 3 to 67% of the single maximum rate of 0.133 lb a.i./A proposed for the US. The one semi-field study that used maximum US application rates was intended for quantifying residues in plant matrices, and thus, has limited biological effects information.

In considering the available information from the semi-field tunnel studies, the following conclusions were reached:

- **Adult mortality, flight activity, behavioral abnormalities.** At the application rates used (3-67% of US maximum), the direct effects of sulfoxaflor on adult forager bee mortality, flight activity and the occurrence of behavioral abnormalities is relatively short-lived, lasting 3 days or less. Direct effects are considered those that result directly from interception of spray droplets or dermal contact with foliar residues. The direct effect of sulfoxaflor on these measures at the maximum application rate in the US is presently not known.

- **Development of Brood.** The effect of sulfoxaflor on brood development is considered <u>inconclusive</u> due to numerous limitations in the design and conduct of the available studies. These limitations include poor performance of control hives, lack of (or short) post-application observation period in order to detect brood effects, and lack of a concurrent control.

- **Colony Strength.** When compared to controls hives, the effect of sulfoxaflor on honey bee colony strength when applied at 3-32% of the US maximum proposed rate was not apparent in most cases. When compared to hives prior to pesticide application, sulfoxaflor applied to cotton foliage up to the maximum rate proposed in the US resulted in no discernible decline in mean colony strength by 17days after the first application. Longer-term results were not available from this study nor were concurrent controls included.

1.5 Data Gaps and Uncertainties

1.5.1 Environmental Fate

Submitted environmental fate data meet the requirements for this screening level assessment with no fate and transport data gaps.

1.5.2 Ecological Effects

The primary uncertainty in the ecological effects data for sulfoxaflor is lack of a reliable Tier 2 semi-field study for assessing impacts on honey bee colony strength and brood development in accordance with OECD-established test guidelines**.** It is further noted that the high variability in sulfoxaflor residues from the cotton residue study and the nature of the cotton flowering introduces uncertainty in the extrapolation of these residue data to other crops. Therefore, additional data on the nature and magnitude of sulfoxaflor residues in one or more pollinator-attractive crops would be needed to address this source of uncertainty. Other uncertainties include lack of definitive toxicity endpoints for passerine birds and larval honey bees.

2. Problem Formulation

Problem formulation provides a strategic framework for the risk assessment. It sets the objectives for the risk assessment and provides a plan for analyzing the data and characterizing the risk (US EPA 1998). By identifying the important components of the risk assessment process, it focuses the assessment on the most relevant ecological receptors (species), chemical properties, exposure routes, and endpoints. The structure of this risk assessment is based on guidance contained in U.S. EPA's *Guidance for Ecological Risk Assessment* (USEPA 1998) and is consistent with procedures and methodology outlined in the Overview Document (USEPA 2004).

2.1 Nature of the Regulatory action

The purpose of this assessment is to evaluate the environmental fate and ecological risks for the proposed new registration of the chemical sulfoxaflor. Under Section 3 of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), U.S. EPA is required to evaluate the potential of new pesticides (and new pesticide uses) to cause adverse effects to the environment. Potential effects to listed species (species on the Federal list of endangered and threatened wildlife and plants) are also considered under the Endangered Species Act in order to ensure that the registration of sulfoxaflor is not likely to jeopardize the continued existence of such listed species or adversely modify their habitat. To these ends, this assessment follows U.S. EPA's guidance on conducting ecological risk assessments and policies for assessing risk to non-target and listed organisms (U.S. EPA, 1998 and U.S. EPA, 2004).

2.2 Nature of the Chemical Stressor

2.2.1 Overview of Pesticide Usage

Sulfoxaflor is proposed for application as a liquid spray applied by ground and aircraft equipment on a variety of crops including beans, berries, canola, citrus, fruits (pome/stone), ornamentals, grains "small", soybeans, tree nuts, turf, vegetables (brassica "leafy" bulb, cucurbits, fruity including okra, leafy, and root & tuber) and watercress. Sulfoxaflor is to be applied to watercress foliage growing in beds completely drained prior to, during and after the application. Aphids appear to be the main target pests for watercress. Given the fact that watercress is harvested for its foliage and mostly propagated by vegetative parts, it is not expected that the chemical will be applied during bloom except in beds used for seed production.

2.2.2 Pesticide Type, Class, and Mode of Action

Sulfoxaflor is a new class of insecticide as it is currently the only member of the sulfoxamine subclass of the neonicotinoid insecticides according to the Insecticide Resistance Action Committee (IRAC).[2] Other subclasses of neonicotinoid insecticides include the cyano-substituted (*e.g*., acetamiprid and thiacloprid) and the nitroguanidine-substituted neonicotinoids (*e.g*., imidacloprid, thiamethoxam, clothianidin and dinotefuran) Its common mode of action (MOA) as a neonicotinoid is that of an agonist of the nicotinic acetylcholine receptor (nAChR) whereby it exhibits excitatory responses including tremors, followed by paralysis and mortality in target insects (Zhu *et al.* 2011). Sulfoxaflor has also not demonstrated cross-resistance in strains of whitefly and brown planthopper that were bred to be highly resistant to the nitroguanidine subclass neonicotinoid such as imidacloprid (Babcock *et al.* 2010; Zhu *et al.* 2011); this lack of cross resistance is believed to be partially due to sulfoxaflor's lack of susceptibility to the metabolic mechanisms that are considered responsible for insect resistance to neonicotinoids (*e.g*., upregulation of monooxygenase [CYP6G1] enzymes). Zhu *et al.* also indicate the specific nature sulfoxaflor binding to the nAChR likely differs from that of other neonicotinoid subclasses. As a result, the IRAC classifies sulfoxaflor in its own subclass (subclass C; sulfoxamines) under Group 4 (nicotinic acetylcholine receptor agonists), whereas nitroguanidine-substituted neonicotinoids such as imidacloprid, acetamiprid and thiamethoxam are in subclass A.

2.2.3 Overview of Physicochemical, Fate, and Transport Properties

Sulfoxaflor is characterized by a water solubility ranging from 550 to 1,380 ppm with low potential for volatilization from dry and wet surfaces. Partitioning coefficient of sulfoxaflor from octanol to water (K_{ow}) suggests low potential for bioaccumulation in aquatic organisms such as fish. According to the registrant, sulfoxaflor is intended to act through both contact action and ingestion and provides both knockdown (symptoms are typically observed within 1-2 hours of application) and residual control (generally provides from 7 to 21 days of residual control).

Sulfoxaflor is a systemic insecticide which displays translaminar movement when applied to foliage. Movement of sulfoxaflor within the plant follows the direction of water transport within the plant (*i.e.*, xylem mobile) as indicated by phosphor translocation studies in several plants including cabbage, pepper and cotton (MRID 48445804). Example phosphor images for cotton from this study are shown in **Figure 1.** From zero to 72 hours, Panel A and B of **Figure 1** indicate little movement of ^{14}C-labeled sulfoxaflor when applied to the cotton leaf (mainly outward to leave edge). In contrast, Panel C and D of **Figure 1** indicate that when sulfoxaflor is applied to the plant stem, it is transported upward to all stem and leaf tissues along the water transpiration stream. Thus, while foliar applications to leaf surfaces would likely result in localised (translaminar) transport, they would also likely involve contact with lower portions of the plant (stems) which would result in 'upward' transport throughout the plant.

[2] http://www.irac-online.org/eClassification/

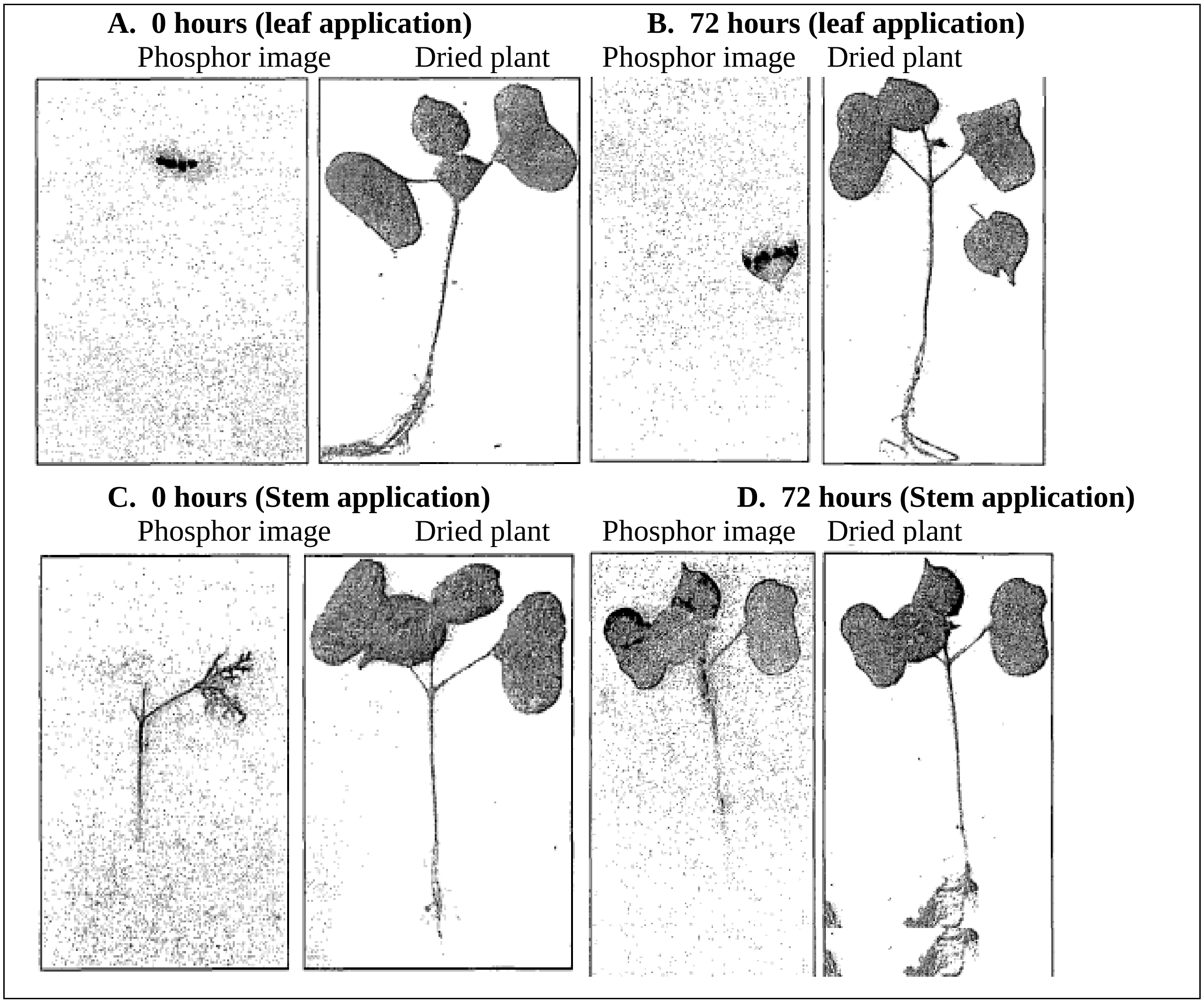


Figure 1. Results from cotton plant translocation study with sulfoxaflor applied to leaf (Panel A&B) and stem (Panel C&D); MRID 48445804

Sulfoxaflor is resistant to hydrolysis and photolysis but transforms quickly in soils. In contrast, sulfoxaflor reaching plant foliage enters into plant tissue and is metabolized into X-474 and X-061. Furthermore, sulfoxaflor reaching aquatic systems by drift is expected to degrade rather slowly.

2.2.4 Stressor Source, Intensity and Identity

Sulfoxaflor is formulated as a suspension concentrate (SC) and water dispersible granules (WDG) and is proposed for application as a liquid spray on variety of crops. It is proposed to be applied to foliage using ground, airblast and/or aerial spray equipments. The maximum single rate of application for sulfoxaflor formulations ranges from 0.043 to 0.133 lb a.i/A with a maximum yearly rates of 0.090 to 0.266 lb a.i/A/year applied in two or three applications at intervals ranging from 5 to 14 days.

In characterizing the nature of this stressor, both exposure and toxicity of the residues of interest (parent, X-474 and X-540) and other degradates are considered for both aquatic and terrestrial systems.

1. Exposure Considerations: For understanding the source and intensity of sulfoxaflor in aquatic systems, a conceptual diagram is used to understand the distribution of expected parent and associated degradates in surface water and ground water (**Figure 2**).

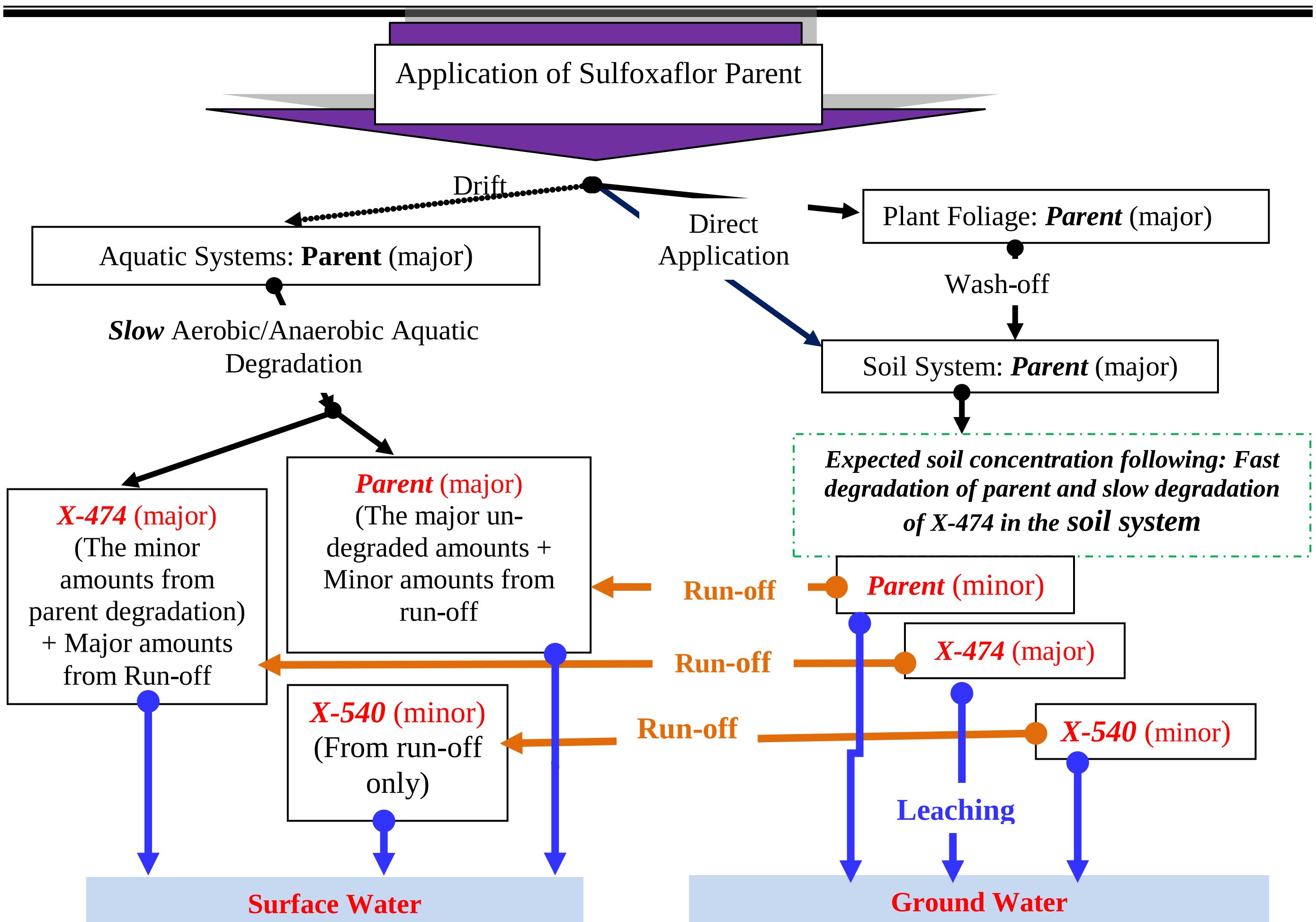


Figure 2. Diagram summarizing distribution of expected residues of interest constituents in surface water and ground water.

As shown in **Figure 2**, the source and intensity of the parent and degradates are expected to be controlled by fate processes dominant in various compartments of the natural environment where the chemicals are expected to reach. These processes include run-off, leaching and spray drift. Partitioning of sulfoxaflor to air is not expected to be important due to the low vapor pressure and Henry's Law constant for sulfoxaflor. Exposure in surface water results from drifted parent as only minor amounts is expected to run-off only when rainfall and/or irrigation immediately follow application. For the degradate **X-**

474, major amounts are expected due to run-off of degraded parent compound in the soil. For the degradate **X-540**, minor amounts are expected from run-off alone.

In terrestrial systems, the source of the pesticide stressor is its foliar application that is expected to mostly reach the foliage and partly reach the soil system as parent. Sulfoxaflor reaching the foliage (including plant stems) is expected to partially move into the plant tissue and degrade over time**.** However, the portion of the parent pesticide that is left on the foliage is expected to stay as parent. The degradate X-474 is also considered relevant to exposure in terrestrial systems, due to biotransformation of parent in soil and subsequent uptake by plants. X-540 is not a major metabolite in plants (observed < 1% of TRR in lettuce metabolism studies and not in all in the other plant metabolism studies).

2. Toxicity Considerations: In aquatic systems, organisms are expected to be exposed to parent sulfoxaflor and the degradation products X-474 and X-540 (**Figure 2).** Comparative toxicity data for one freshwater fish and one freshwater invertebrate species indicate that sulfoxaflor and X-474 are both practically non-toxic on an acute exposure basis (LC_{50} values are all >100 mg a.i/L; See **Section 4** for additional discussion). No chronic toxicity data are available for comparing the toxicity of sulfoxaflor and its degradates to aquatic organisms. Toxicity data for mammals and birds indicate that X-474 is less acutely toxic compared to parent sulfoxaflor, while the minor degradate, X-540, is about 2X more acutely toxic than parent based on mammalian acute LD_{50} data. There is also indication for increased toxicity of X540 compared to parent in a subchronic mammalian dietary study; however, the endpoints quantified (liver weight, mitotic figures) are not quantitatively linked to assessment endpoints used for ecological risk assessment (e.g., survival, growth, reproduction).

For terrestrial organisms, available data indicate that the degradate X-474 is much less toxic than the parent to birds, mammals, and insects (honey bee) on an acute exposure basis (See **Section 4** for details). Furthermore, results from the Health Effects Division assessment of residues of concern indicate the mode of action of sulfoxaflor is not conserved with X-474 (D398294). Regarding the degradate X-061, mammalian acute toxicity data indicate it is about 2X less toxic than the sulfoxaflor parent and practically non-toxic to the honey bee. Although X-540 is more acutely toxic than parent sulfoxaflor to the rat, X-540 is not a major metabolite in plants as indicated above.

3. Stressors of Concern. For aquatic organisms, **the stressor of concern to aquatic organisms is considered to be "sulfoxaflor parent + X-540**, assuming equal toxicity as parent sulfoxaflor. The equal toxicity assumption between parent and X-540 is based on the similarity in their acute oral toxicity to mammals (i.e., within a factor of two). Although X-474 is considered a major degradate, it is not included in the stressor for aquatic organisms because of its lack of acute toxicity, expectation that it does not share the same MOA as parent due to loss of cyano-substitution, and QSAR results indicating its low toxicity.

For terrestrial animals (birds, mammals, and terrestrial invertebrates), **the stressor of concern is defined as parent sulfoxaflor only**. This definition considers the lower potency of the two primary degradation products in plants (X-474 and X-061) and lack of significant exposure expected for X-540. This stressor definition is also consistent with HED's residue of concern findings for defining residue tolerance values in crops. For terrestrial plants, the stressor is defined as sulfoxaflor only given that no comparative toxicity data for plants are available for the parent or degradates and that parent chemical was not toxic to terrestrial plants at or above the proposed maximum application rates.

2.3 Ecological Receptors

The receptor is the biological entity that is exposed to the stressor (US EPA, 1998). Aquatic receptors potentially at risk include (but are not limited to): fish, amphibians, invertebrates (*e.g.*, aquatic insects, mollusks, crustaceans, and worms), vascular and nonvascular aquatic plants. Terrestrial receptors potentially at risk include (but are not limited to): birds, mammals, reptiles, amphibians, terrestrial invertebrates (*e.g.*, insects, worms, arachnids), and plants.

Consistent with the process described in the Overview Document (US EPA, 2004), this risk assessment uses the surrogate species approach in its evaluation of sulfoxaflor. Toxicological data generated from surrogate test species, that are intended to be representative of broad taxonomic groups, are used to extrapolate to potential effects on a variety of species (receptors) included under these taxonomic groupings.

Acute and chronic toxicity data from studies submitted by pesticide registrants along with the available open literature are used to evaluate potential direct effects of sulfoxaflor to the aquatic and terrestrial receptors identified in this section. Since sulfoxaflor is a new active ingredient, the availability of open literature information on its toxicity is expected to be limited. The open literature studies are identified through EPA's ECOTOX database (http://cfpub.epa.gov/ecotox/), which employs a literature search engine for locating chemical toxicity data for aquatic life, terrestrial plants, and wildlife. The evaluation of both sources of data can also provide insight into the direct and indirect effects of sulfoxaflor on biotic communities due to loss of species that are sensitive to the chemical and changes in structure and functional characteristics of the affected communities.

A summary of the taxonomic groups and the surrogate species tested to help understand potential acute ecological effects of pesticides to non-target species is provided in **Table 2**. In addition, the table provides a preliminary overview of the potential acute toxicity of sulfoxaflor by providing the acute toxicity classifications.

Table 2. Taxonomic Groups, Test Species and Acute Toxicity Classification for Assessing Ecological Risks of Sulfoxaflor to Non-target Organisms

Taxonomic Group	Example(s) of Surrogate Species	Acute Toxicity Classification
Birds[1]	Mallard duck (*Anas platyrhynchos*) Bobwhite quail (*Colinus virginianus*) Zebra finch (*Poephila guttata*)	Practically non-toxic Slightly toxic Moderately toxic
Mammals	Laboratory rat (*Rattus norvegicus*)	Slightly toxic

Taxonomic Group	Example(s) of Surrogate Species	Acute Toxicity Classification
Insects	Honey bee (*Apis mellifera L.*) Bumble bee (*Bombus terrestris*)	Very highly toxic Moderately toxic
Freshwater fish[2]	Bluegill sunfish (*Lepomis macrochirus*) Rainbow trout (*Oncorhynchus mykiss*) Carp (*Cyprinus carpio*)	Practically non-toxic
Freshwater invertebrates	Water flea (*Daphnia magna*)	Practically non-toxic
Estuarine/marine fish	Sheepshead minnow *(Cyprinodon variegatus)*	Practically non-toxic
Estuarine/marine invertebrates	Mysid shrimp *(Americamysis bahia)* Eastern oyster (*Crassostrea virginica*)	Highly toxic Practically-non toxic

[1] In absence of data, birds are used as surrogates for terrestrial-phase amphibians and reptiles.
[2] In absence of data, freshwater fish may be surrogates for aquatic-phase amphibians.

2.4 Ecosystems at Risk

The ecosystems at potential risk from sulfoxaflor are extensive in scope due to the wide geographic distribution of potential sulfoxaflor application sites. In general terms, terrestrial ecosystems potentially at risk could include the treatment areas directly and adjacent areas that may receive drift or runoff. This could include the treatment area itself as well as other cultivated fields, fencerows and hedgerows, meadows, fallow fields or grasslands, woodlands, riparian habitats and other uncultivated areas.

Aquatic ecosystems potentially at risk include water bodies adjacent to (or downstream from) the treatment area and might include impounded bodies such as ponds, lakes, reservoirs and wetland areas, or flowing waterways such as streams and rivers. For uses in coastal areas, aquatic habitat also includes marine ecosystems, including estuaries and salt marshes.

2.5 Assessment Endpoints

Assessment endpoints represent the actual environmental value that is to be protected, defined by an ecological entity (species, community, or other entity) and its attribute or characteristics (US EPA, 1998). For sulfoxaflor, the ecological entities may include the following: birds, mammals, freshwater fish and invertebrates, estuarine/marine fish and invertebrates, terrestrial plants, insects, and aquatic plants and algae. The attributes for each of these entities may include growth, reproduction, and survival and are discussed further in **Section 2.7: (Analysis Plan)**.

2.6 Conceptual Model

For a pesticide to pose an ecological risk, it must reach ecological receptors in biologically significant concentrations. An exposure pathway is the means by which a pesticide moves in the environment from a source to an ecological receptor. For an ecological pathway to be complete, it must have a source, a release mechanism, an environmental transport medium, a point of exposure for ecological receptors, and a feasible route of exposure.

A conceptual model is used in this risk assessment to provide a written and visual description of the predicted relationships between sulfoxaflor, potential routes of exposure, and the predicted effects for the assessment endpoint. A conceptual model consists of two major components: risk hypotheses and a conceptual diagram (US EPA, 1998).

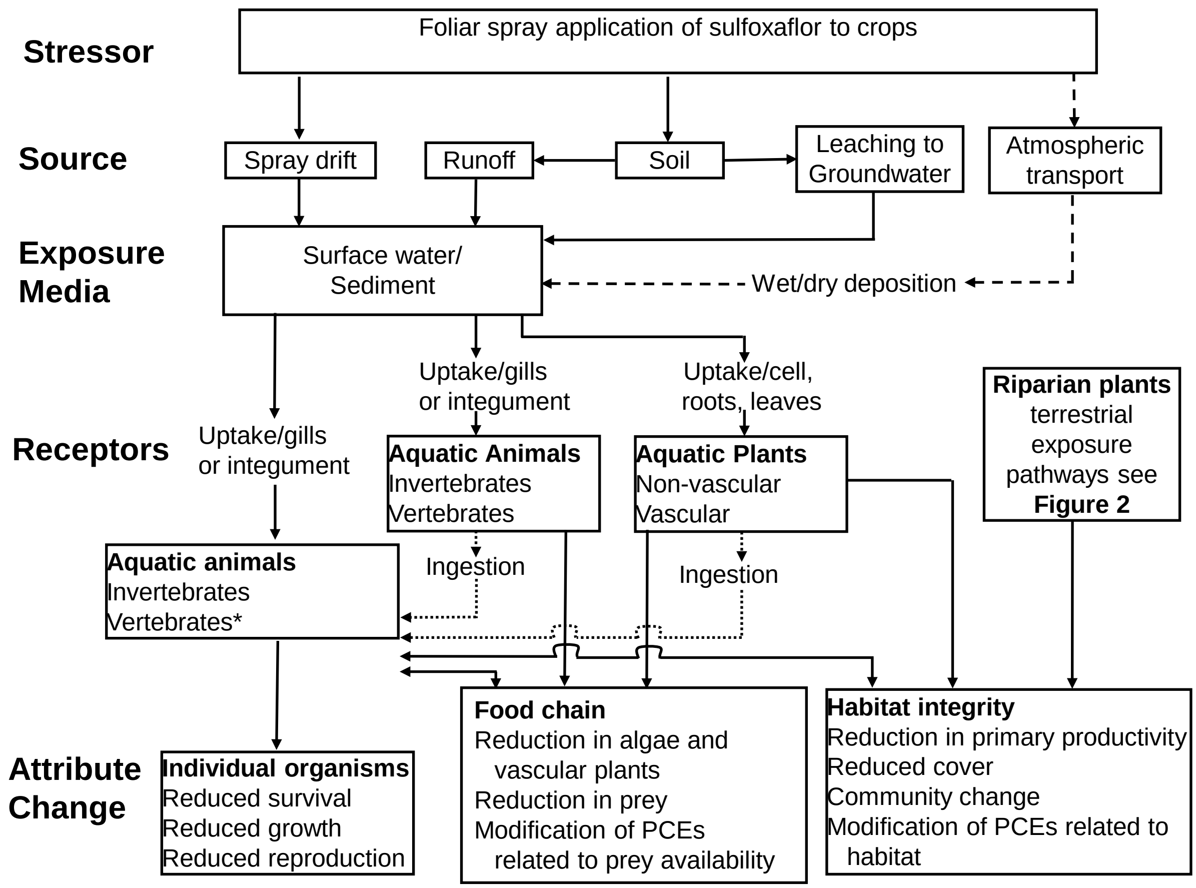
2.6.1 Diagram

Based on the preliminary iterative process of examining fate and effects data, the conceptual model or the risk hypothesis model for spray application to agricultural crops has been established, refined and included in **Figure 3, Figure 4,** and **Figure 5**, respectively. In establishing the diagram for the conceptual model it was necessary to go through an iterative process to identify: (1) likely stressors/exposure pathways and (2) organisms that are most relevant and applicable to this assessment.

Primary exposure routes for aquatic organisms include spray drift and runoff of sulfoxaflor (and its degradates) into nearby bodies of water. Once in the water, the primary exposure route to aquatic organisms is direct uptake across respiratory membranes (animals) and roots/integument (plants). Dietary uptake (ingestion) is not considered an important exposure pathway given the very low bioaccumulation potential of sulfoxaflor.

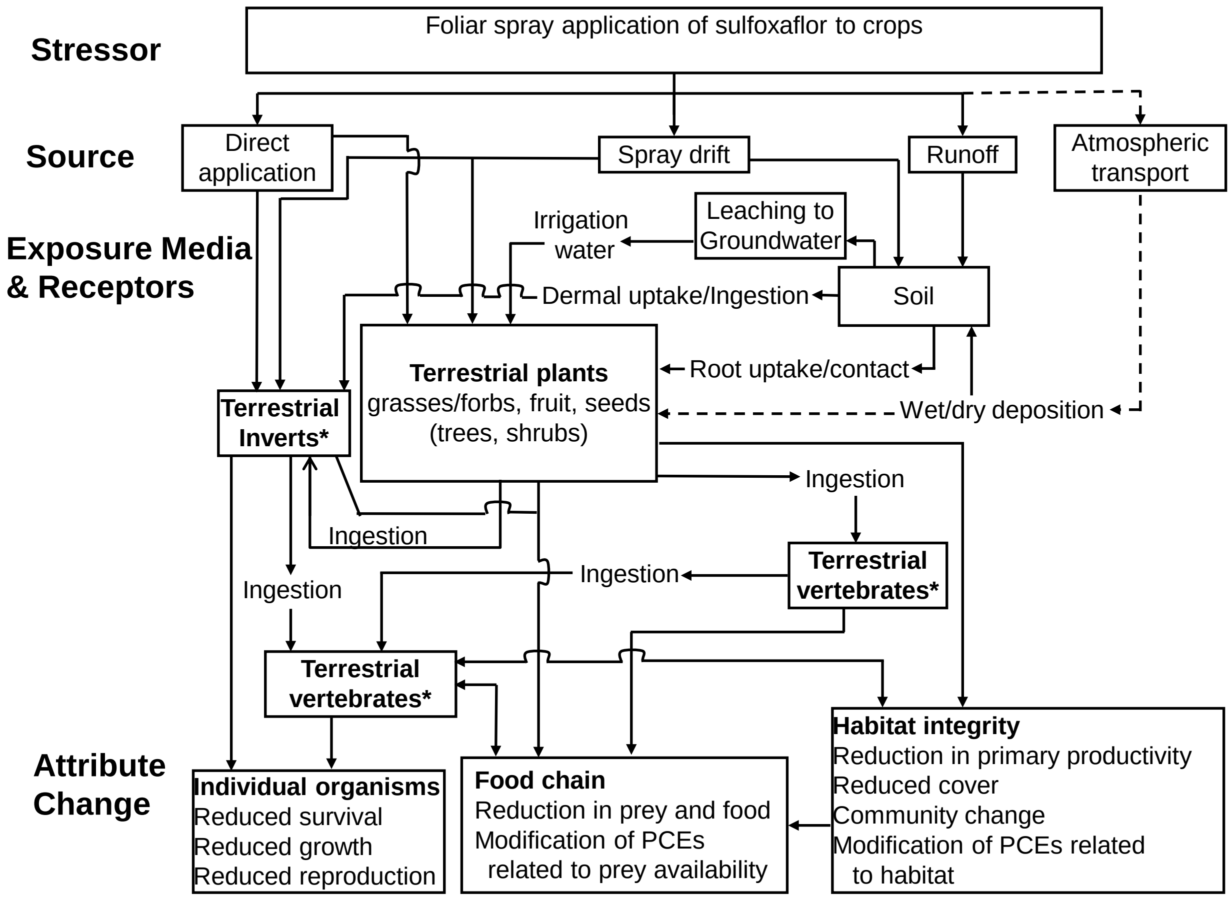
Primary exposure routes for terrestrial organisms (except bees) include direct contact with spray droplets, dermal contact with foliar residues, uptake from soil (plants and soil invertebrates) and consumption of contaminated foliage (herbivorous animals). Inhalation is not considered an exposure route of concern based on results of the Screening Tool for Inhalation Risk (STIR; version 1.0) model (**Appendix E**). Consumption of contaminated drinking water is a potential exposure route of concern based on results of Screening Imbibition Program (SIP; version 1.0; **Appendix E**). However, additional refinements are needed to determine if actual risks result from this exposure pathway. At this time, EFED has does have available an approved modeling tool to enable refinements to the SIP screening model.

For managed bees (e.g., honey bees), the primary exposure routes of concern include direct contact with spray droplets, dermal contact with foliar residues, and ingestion through consumption of contaminated pollen, nectar and associated processed food provisions (*e.g.*, brood food, royal jelly, propolis). Exposure of hive bees via contaminated wax is also possible, although difficult to quantify at this time. Exposure of bees through contaminated drinking water is not expected to be nearly as important as exposure through direct contact or pollen and nectar (USEPA, 2012).



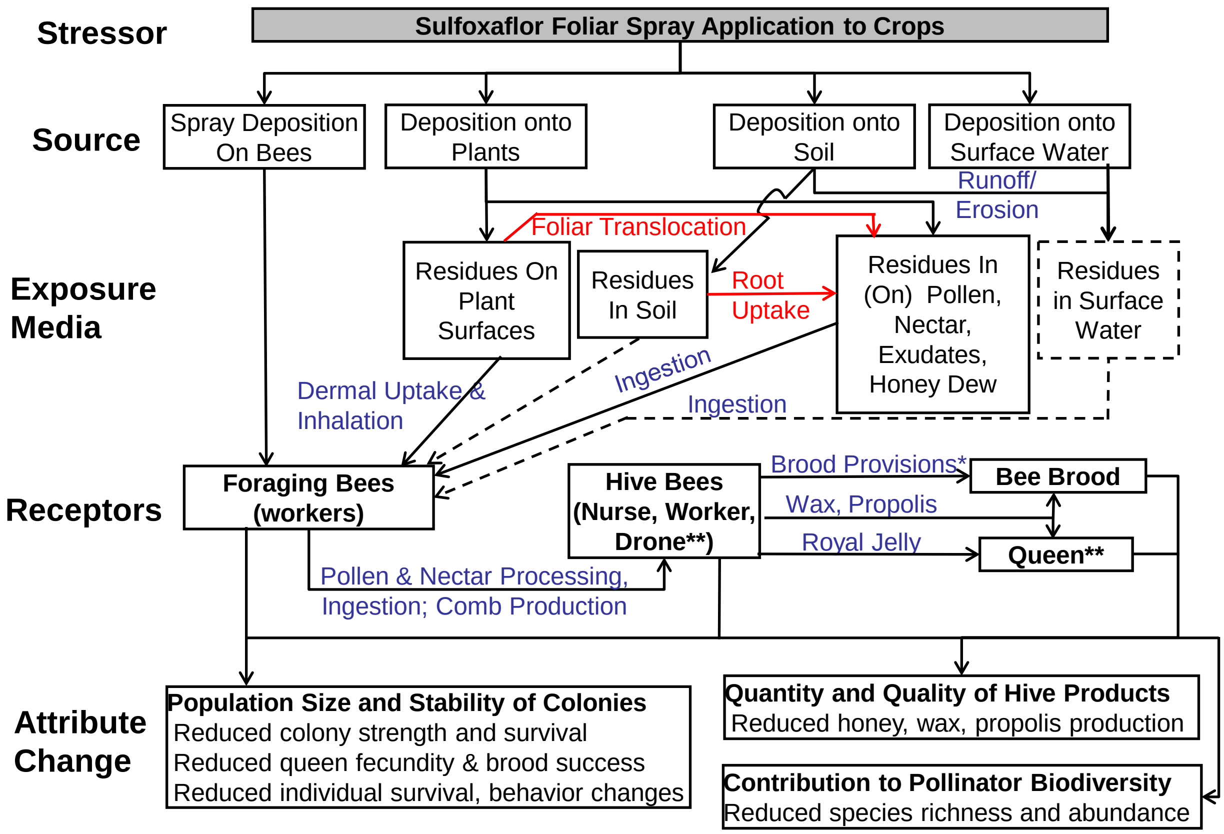
* Exposure of piscivorous wildlife via ingestion of aquatic organisms is not an exposure pathway of concern for sulfoxaflor

Figure 3. An ecological conceptual model for aquatic exposure from spray application of sulfoxaflor



* See **Figure 3** for a detailed conceptual model of sulfoxaflor risks to honey bees.

Figure 4. An ecological conceptual model for terrestrial exposure from spray application of sulfoxaflor



* Brood initially rely on brood jelly and royal jelly, but later in development consume processed pollen and honey; whereas queens rely solely on royal jelly.
** interception of spray droplets is also a potential route of exposure during mating and orientation flights

Figure 5. An ecological conceptual model for honey bee exposure from spray application of sulfoxaflor

2.6.2 Risk Hypothesis

Risk hypotheses are specific assumptions about potential adverse effects (*i.e.*, changes in assessment endpoints) and may be based on theory and logic, empirical data, mathematical models, or probability models (EPA 1998). The ensuing risk assessment will evaluate whether or not the specific risk hypotheses are supported. For foliar applications of sulfoxaflor, the following ecological risk hypothesis is being employed for this risk assessment:

> *Based on the environmental fate, systemic uptake and distribution by plants and nature of foliar applications of sulfoxaflor to crops, (including its primary degradates of concern), there is a potential that terrestrial and/or aquatic organisms will be exposed when sulfoxaflor is used in accordance with the label. Consequently, considering the MOA and toxicity of sulfoxaflor, the proposed uses of sulfoxaflor have the potential to cause adverse effects upon the survival, growth, and reproduction of non-target terrestrial and aquatic plants and animals.*

2.7 Analysis Plan

2.7.1 Methods for Conducting Ecological Risk Assessment

The primary method used to assess risk in this screening-level assessment is the risk quotient (RQ) and follows closely methods outlined in the EPA Overview Document (USEPA, 2004). The RQ is the risk value for the screening-level assessment and is the result of comparing measures of exposure to measures of effect. A commonly used measure of exposure is the estimated exposure concentration (EEC) and commonly used measures of effect include toxicity values such as the median lethal dose to 50% of the organisms tested (LD_{50}), medial lethal concentration to 50% of tested organisms (LC_{50}), the no observed adverse effect level (NOAEL)[3], and the no observed adverse effect concentration (NOAEC). The resulting ratio of the point estimate of exposure and the point estimate of toxicity, i.e., the RQ, is then compared to a specified level of concern (LOC), which represents a threshold for concern; if the RQ exceeds the LOC, risks concerns are triggered. Risk presumptions, along with the corresponding RQs, equations, and LOCs are summarized in
Section 5.

Generation of robust RQs is dependent on the quality of data from both fate and toxicological studies. The adequacy of the submitted data was evaluated relative to Agency guidelines. The following identified data gaps for ecological fate and toxicity endpoints result in a degree of uncertainty in evaluating the ecological risk of sulfoxaflor.

[3] A NOAEL refers to a dose-based toxicity endpoint whereas a NOAEC refers to a concentration based endpoint.

2.7.2 Measures of Exposure

Measures of exposure are estimates of exposure for a receptor determined by modeling or monitoring data. Measures of exposure for sulfoxaflor, in this assessment, are obtained from modeling efforts only, since this is a new chemical and national-scale monitoring data are not expected to be present. Exposure models used for this assessment include the suite of standard exposure models commonly used in pesticide risk assessments (USEPA, 2004). Generally, aquatic exposure estimates are generated from EPA models and incorporate maximum proposed use rates, minimum application intervals, and empirically-derived fate properties. Further details of the exposure models can be found in the Exposure Characterization section of the risk assessment and on the web.

http://www.epa.gov/oppefed1/models/water/index.htm

Exposure to aquatic organisms is assumed to occur through direct contact with surface water contaminated by drift and/or runoff/erosion from agricultural fields. Aquatic exposure concentrations, for all crops except watercress, in this assessment were based on EECs calculated using Tier II-linked Pesticide Root Zone Model (version 3.12.2 Carousel *et al.*, 2005) and the Exposure Analysis Modeling System (version 2.98.04; Burns, 1997) referred to as PRZM/EXAMS. Model runs were executed using graphic interface (EXPRESS or PE-5). For watercress, EECs were conservatively estimated using the Tier 1 Rice Model.

Measures of exposure for terrestrial mammals, birds, reptiles and amphibians similarly incorporate maximum proposed use rates, but rely less on environmental fate properties. Terrestrial exposures were estimated using a number of methods. The Kenaga nomogram, as modified by Fletcher *et al*., (Kenaga and Hoerger 1972; Fletcher *et al*. 1994) is used to relate pesticide application rates to chemical residues on terrestrial food items. The surface residue concentration (in parts per million; ppm) is estimated by multiplying the application rate (pounds active ingredient per acre; lbs a.i./A) by a value specific to each food item. For numerous applications for a given use, the Terrestrial Exposure (T-REX; version 1.5.1) model is used with the maximum application rates and minimum application intervals allowable on the proposed labels. Degradation is considered using a first-order decay rate dependent on a chemical-specific foliar dissipation half-life of 12.3 days for sulfoxaflor based on submitted residue-decline data. The conceptual approach taken to estimate residues (upper-bound and mean) in potential dietary sources for mammals and birds is presented in the model T-REX Version 1.5.1 available at:

http://www.epa.gov/oppefed1/models/terrestrial/index.htm

Exposure of non-target terrestrial and semi-aquatic plants to sulfoxaflor is estimated using the TerrPlant model (version 1.2.2) which accounts for both spray drift and runoff as a function of application rate.

Exposure of honey bees to sulfoxaflor is estimated using a Tiered approach as outlined in USEPA (2012): *Draft Framework for Pollinator Risk Assessment*[4]. Tier 1 of this draft framework involves estimating pesticide doses to honey bees from direct contact using an upper-bound estimate of 2.7 µg a.i/bee per 1 lb a.i/A and an upper-bound estimate of oral ingestion using the T-REX model for arthropod residues. Further refinement of the oral doses is conducted using available measured pesticide residue information for pollen and nectar. Additional information on estimation of oral and contact doses to honey bees is provided in **Appendix D.**

2.7.3 Measures of Effect

Measures of ecological effects are obtained from a suite of registrant-submitted guideline studies conducted with a limited number of surrogate species. The test species are not intended to be representative of the most sensitive species but rather were selected based on their ability to thrive under laboratory conditions. Measures of effect are based on deleterious changes in an organism as a result of chemical exposure. Functionally, measures of effect typically used in risk assessments include changes in survival, reproduction, or growth as determined from standard laboratory toxicity tests. The focus on these effects for quantitative risk assessment is due to their clear relationship to higher-order ecological systems such as populations, communities, and ecosystems. Although monitoring data such as adverse effect incident reports may also be used to provide supporting lines of evidence for the risk characterization, monitoring data are lacking for this new chemical. Over the 2012 growing season, a Section 18 emergency use was granted for application of sulfoxaflor to cotton in four states (MS, LA, AR, TN). To date, no incident reports have been received in association with the use of sulfoxaflor. However, due to the nature of ecological incident reporting, absence of incidents cannot be construed with absence of incidents. In addition, effects other than survival, reproduction, and growth may be considered, rarely are they used quantitatively to estimate risks since, in many cases, the relationship between these effects and higher-order processes is tenuous at best. Commonly used laboratory-derived toxicity values include estimates of acute mortality (*e.g.*, LD_{50}, LC_{50}) and estimates of effects due to longer term, chronic exposures (*e.g.*, NOAEC, NOAEL). The latter can reflect changes seen in mortality, reproduction, or growth. In general, for a given assessment endpoint the lowest (*i.e*., most sensitive) relevant measure of effect is used is calculating the RQ. In addition, for insect pollinators (honey bee), effects are also assessed at the colony level using semi-field and/or full-field studies. Measurement endpoints include colony strength, foraging activity, forager mortality, and various measures of brood development.

Assessment endpoints and their respective measures of effect are listed in **Table 3**.

[4] http://www.epa.gov/scipoly/sap/meetings/2012/091112meeting.html

Table 3. Summary of assessment and measurement endpoints for Sulfoxaflor

Assessment Endpoint	Measures of Exposure	Measures of Effect
1. Abundance (i.e., survival, reproduction, and growth) of individuals and populations of birds[2].	Maximum (peak) residues on food items (foliar)	1a. Zebra finch and mallard duck acute oral LD_{50}. 1b. Mallard duck subacute dietary LC_{50}. 1c. Mallard duck and bobwhite quail chronic reproduction NOAEC and LOAEC.
2. Abundance (i.e., survival, reproduction, and growth) of individuals and populations of mammals.	Maximum (peak) residues on food items (foliar)	2a. Laboratory rat and mouse acute oral LD_{50}. 2b. Laboratory rat 2-generation reproduction chronic NOAEL and LOAEL.
3. Survival and reproduction of individuals and communities of freshwater fish[3] and invertebrates.	Peak EEC (acute), 21-d & 60-d surface water EEC (chronic)[1]	3a. Rainbow trout, bluegill sunfish and carp acute LC_{50}. 3b. Fathead minnow early life stage NOAEC and LOAEC. 3c. Daphnid acute EC_{50}. 3d. Daphnid chronic reproduction NOAEC and LOAEC.
4. Survival and reproduction of individuals and communities of estuarine/marine fish and invertebrates.	Peak EEC (acute), 21-d & 60-d surface water EEC (chronic)[1]	4a. Sheepshead minnow acute LC_{50}. 4b. Saltwater mysid acute LC_{50}.
5. Survival of individuals and communities of freshwater and estuarine/marine benthic organisms.	21-d pore water and sediment EEC[1]	5a. Freshwater midge subchronic NOAEC and LOAEC. 5b. Estuarine/marine mollusk acute EC_{50} based on shell deposition.
6. Perpetuation of individuals and populations of non-target terrestrial plant species.	Estimates of runoff and spray drift to non-target areas	6a. Monocot and dicot seedling emergence and vegetative vigor EC_{25} values.
7. Maintenance and growth of individuals and populations of aquatic vascular and nonvascular plants.	Peak surface water EEC	7a. *Lemna gibba* acute EC_{50} values based on yield and growth rate. 7b. Algal acute EC_{50} values based on cell density, biomass and growth rate.
8. Population size and stability of managed bee colonies; Quality of hive products	Upper bound oral and contact dose to adult and larvae (laboratory studies)	8a. Honey bee adult acute contact LD_{50}. 8b. Honey bee adult acute oral LC_{50}. 8c. Honey bee larval chronic NOAEC or LD_{10} 8d. Honey bee colony level effects

Assessment Endpoint	Measures of Exposure	Measures of Effect
LD_{50} = Lethal dose to 50% of the test population; NOAEC = No-observed-adverse-effect level; LOAEC = Lowest-observed-adverse-effect level; LC_{50} = Lethal concentration to 50% of the test population; EC_{50}/EC_{25} = Effect concentration to 50/25% of the test population. [1] Based on a 1-in-10-year return frequency. [2] According to EFED risk assessment guidance, birds may be used as surrogates for amphibians (terrestrial phase) and reptiles. [3] According to EFED risk assessment guidance, freshwater fish may be used as surrogates for amphibians (aquatic phase).		

3. Analysis

3.1 Use Characterization

Sulfoxaflor is proposed to be widely used in the U.S. to control or suppress a wide range of insect pests including aphids, plant bugs, stink bugs, whiteflies and certain scales, thrips and psyllids. The list of the proposed crop uses include barley, Brassica (cole) leafy vegetables, bulb vegetables, canola (rapeseed), citrus, cotton, cucurbit vegetables, fruiting vegetables, leafy vegetables (except *Brassica*), leaves of root and tuber vegetables, low growing berry, okra, ornamentals (herbaceous and woody), pistachio, pome fruits, root and tuber vegetables, small fruit vine climbing (except fuzzy kiwifruit), soybean, stone fruits, succulent, edible podded, and dry beans, tree nuts, triticale, turf grass, watercress, and wheat. Sulfoxaflor is formulated as a suspension concentrate "SC" (Proposed label: GF-2032 SC containing 2 lb a.i/gal) and as water dispersible granule "WG" (Proposed label: GF-2372 WG or Transform™ WG containing 50% a.i by weight. Formulations are proposed to be applied as liquid spray by ground, airblast, and aerial into the crop foliage. The potential usage areas may be inferred from the proposed crop use patterns. The spatial extent of usage areas is expected cover large acreages of the proposed crop land in the U.S. **Table 4** contains a summary of all crops proposed to be treated with sulfoxaflor.

Table 4. Crop use patterns proposed for sulfoxaflor; Ground or aerial for all uses except for turf and non-commercial ornamentals (ground application)*

*Crop/Crop Group***	*Crop Group(CG) Or Subgroup (SG)*	*Max Single Rate (lb a.i./A)*	*Max No. of Applications*	*Max Yearly Rate (lb a.i./A)*	*Min Intervals (days)*
Beans	Beans	0.090	3	0.266	7
Berries	SG 13-07F &G	0.090	3	0.266	7
Canola (Rapeseed)	SG 20A	0.043	2	0.090	14
Citrus	CG 10	0.133	2	0.266	7
Cotton	Cotton	0.090	3	0.266	5
Fruits: Pome	CG 11	0.133	2	0.266	7
Fruits: Stone	CG 12	0.133	2	0.266	7
Grains	Small Grains	0.043	2	0.090	14
Ornamentals	Ornamentals	0.133	2	0.266	7
Soybeans	Soybeans	0.090	3	0.266	7
Tree Nuts	CG 14 & Pistachio	0.133	2	0.266	7
Turf grass	Turf grass	0.133	2	0.266	7
Vegetables: Brassica (cole) leafy	CG 5	0.090	3	0.266	7
Vegetables: Bulb	SG 3-07	0.090	3	0.266	7

Crop/Crop Group**	Crop Group(CG) Or Subgroup (SG)	Max Single Rate (lb a.i./A)	Max No. of Applications	Max Yearly Rate (lb a.i./A)	Min Intervals (days)
Vegetables: Cucurbit	CG 9	0.090	3	0.266	7
Vegetables: Fruiting & Okra	CG 8 & Okra	0.090	3	0.266	7
Vegetables: Leafy except Brassica	CG 4	0.090	3	0.266	7
Vegetables: Root & tuber /Leaves	CG 1 & 2	0.090	3	0.266	7
Watercress	Watercress	0.090	3	0.266	7

* from pre-bloom to mature fruits for trees and from seeding to harvest for all others
** For detailed crop listing refer to **Appendix A**

3.2 Exposure Characterization

3.2.1 Environmental Fate and Transport Characterization

3.2.1.1 Physical and chemical properties

The physical and chemical properties of Sulfoxaflor are summarized in **Table 5**. These data indicate that the chemical is characterized by a water solubility ranging from 550 to 1,380 ppm in alkaline to acidic conditions, respectively. Sulfoxaflor has a low potential for volatilization from dry and wet surfaces (vapor pressure= 1.9 x 10^{-8} torr and Henry's Law constant= 1.2 x 10^{-11} atm m^3 $mole^{-1}$, respectively at 25 °C). Partitioning coefficient of sulfoxaflor from octanol to water (K_{ow}) suggests low potential for bioaccumulation in aquatic organisms such as fish. However, the logarithm of its portioning coefficient from octanol to air (Log K_{oa}=10) suggests potential bioaccumulation in terrestrial organisms, but the expected relative availability in air is low because amount expected to partition into air is low (low volatility) and it's half-life in the air is expected to be short (range of 8-16 hours). Furthermore, sulfoxaflor is not expected to partition into the sediment due to low K_{oc}.

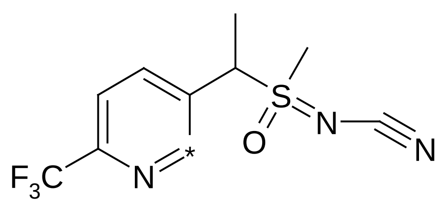
Table 5. Physical and chemical properties of Sulfoxaflor

Property	*Description or Value*	*Reference**
CAS Name	Sulfoxaflor: cyanamide, N-[methyloxido[1-[6-(trifluoromethyl)-3-pyridinyl]ethyl]-lambda 4-sulfanylidene]-	
Molecular Formula	$C_{10}H_{10}F_3N_3OS$	
CAS number	946578-00-3	
PC code	005210	
Molecular Weight	277.27 g/mol	Registrant Data

Property	*Description or Value*	*Reference**
Solubility (mg/L @ 20 C)	**Parent** **X-474** pH 5 → 1,380 mg/L 7,270 mg/L pH 7 → 570 mg/L 7,200 mg/L pH 9 → 550 mg/L 8,480 mg/L In purified water: 670 mg/L 8,090 mg/L	478320-10 478320-23 for X-474
Vapor pressure	Parent 20°C → $\leq 1.1 \times 10^{-8}$ torr; $\leq 1.4 \times 10^{-6}$ Pa; $\leq 1.4 \times 10^{-11}$atm 25°C → $\leq 1.9 \times 10^{-8}$ torr; $\leq 2.5 \times 10^{-6}$ Pa; $\leq 2.5 \times 10^{-11}$atm X-474 25°C → $\leq 2.0 \times 10^{-9}$ torr; $\leq 2.7 \times 10^{-7}$ Pa; $\leq 2.7 \times 10^{-12}$atm	478320-06 478320-22 for X-474
Henry's Law Constant (@ 20 & 25 C)	6.7×10^{-12} atm m^3 $mole^{-1}$; 5.1×10^{-9} torr m^3 $mole^{-1}$ 1.2×10^{-11} atm m^3 $mole^{-1}$; 9.1×10^{-9} torr m^3 $mole^{-1}$	478320-07 from VP at 20°C Calculated from VP at 25°C
Half-life in Air ($t_{½}$ in hours)	range: 7.8 - 15.5	EPI-Suit v3.2 (AOPWIN) & Level III Fugacity Model
Log K_{oa}	10.11	EPI-Suit v3.2 (KOAWIN)
K_{ow} @ 20 C & pH 7	Parent: 6 (Log K_{ow} = 0.802) X-474, X-540 and X-457: <2 (Log K_{ow} = 0.3)	478320-11 478320-20/24/27
K_{oc}	7 – 74 mL/g	

3.2.1.2 Fate and Transport Properties

The fate and transport behaviour of Sulfoxaflor had been investigated in a series of laboratory and field studies. The submitted laboratory studies were all conducted with ^{14}C-labelled active substance in the pyridine ring as shown in **Figure 6**.



* denotes position of radiolabel in the pyridine ring

^{14}C-Sulfoxaflor (or XDE-2208)

Figure 6. Radiolabeled sulfoxaflor used in fate and transport studies

Sulfoxaflor consists of two diastereomers in a ratio of approximately 50:50. Each of the diastereomers consists of two enantiomers that cannot be resolved using conventional (non-chiral) high pressure liquid chromatography (HPLC) columns.

a) Abiotic Degradation

Results indicate that hydrolysis, and both aqueous and soil photolysis are not expected to be important in sulfoxaflor dissipation in the natural environment. The fate properties of sulfoxaflor parent and major degradate X-474 in abiotic systems are summarized in **Table 6**. In a hydrolysis study, the parent was shown to be stable in acidic/neutral/alkaline sterilized aqueous buffered solutions (pH values of 5, 7 and 9; MRID 47832-149). In addition, parent chemical as well as its major degradate, were shown to degrade relatively slowly by aqueous photolysis in sterile and natural pond water (t½= 261 to >1,000 days; MRID 478322-83/84). Furthermore, sulfoxaflor was stable to photolysis on soil surfaces (MRID 478320-21).

Table 6. Fate properties of sulfoxaflor parent and its major degradate X-474 in abiotic systems

Property	***Description or Value & Other Relevant Information***	***Reference (MRID)***
Hydrolysis half-life @ 25 °C	**Parent:** **Stable** in sterile aqueous buffered solution at pH values of 5, 7 and 9 **X474 degradate** **(**no study; results inferred from the dark controls of the aqueous photolysis study (MRID 478322-83): **Stable** in sterile aqueous buffered solution at pH7	478321-49
Environmentally relevant Aqueous photolysis half-lives @ 25 °C; 40° N latitude in summer sunlight	**Parent:** **>1,000 days** in sterile aqueous buffered solution at pH 7.0 **637 days** in natural pond water, Italy; buffered at pH 8.2 **Major degradates: None** **Minor degradates:** X-061 [1-[6-(trifluoromethyl)(2-14C)pyridin-3-yl]ethanol] with a maximum of 2.5% @ study termination (day 14) **(Note: Transformation products was not tracked for the natural pond water samples, transformation products data above are for sterile/buffered water only)** **X-474 degradate:** **261 days** in sterile aqueous buffered solution at pH 7 **>1,000 days** in natural pond water, Italy; buffered at pH 8.2 **Major degradates:** **None** **Minor degradate:** X-061 (maximum 4.4% at study termination) and X-922 [1-(6-trifluoromethyl-pyridine-3-yl) ethanone] with a maximum of 8.6% at study termination (day 14)	Sterile Water Study: 478322-83 Natural water study: 478322-84
Soil photolysis half-life	**Stable**	478320-21

b) Biotic Degradation

The fate properties of sulfoxaflor and its major degradation product X-474, in biotic systems, are summarized in **Table 7**. In addition, **Table 8** contains a summary for the degradation products observed following parent degradation in various systems. Expected environmental degradation pathways and transformation profiles for Sulfoxaflor are also presented in **Figure 7**.

Based on these data, sulfoxaflor is expected to biodegrade rapidly in aerobic soil (half-lives <1 day). Under aerobic aquatic conditions, biodegradation proceeded at a more moderate rate with half-lives ranging from 37 to 88 days. The major degrade formed in aerobic soil/aquatic systems is X-474. Under anaerobic soil conditions, the parent compound was metabolized with half-lives of 113 to 120 days while under anaerobic aquatic conditions the chemical was more persistent with half-lives of 103 to 382 days.

In contrast to its short-lived parent, the major degradate X-474 is expected to be more persistent than its parent in aerobic/anaerobic aquatic systems and some aerobic soils. In other soils, less persistence is expected due to mineralization to CO_2 or the formation of other minor degradates.

Table 7. Fate properties of sulfoxaflor parent and major degradate X-474 in biotic systems

Property	*Soil or Water/Sediment System**	*Half-life & (Fitting Equation)*		*Reference (MRID)*
		Parent t½	*X-464 t½*	
Aerobic Soil Metabolism (days): 25 °C/ 75% of the water holding capacity (**WHC**)	Lenawee light clay, Michigan, USA: CL	**0.3**	**>1000**	478655-78
	Pullman light clay, Texas, USA: CL	**0.4**	**>1000**	
	Fayette clay loam, Iowa, USA: L	**0.6**	**>1000**	
	Slagle clay loam, Virginia, USA: SL	**0.5**	**>1000**	
Aerobic Soil Metabolism (days): EU Soils incubated for 4 months at 20 °C/ 40% of the **WHC**	Cranwell Series (Site I), Lincolnshire, UK: LS	**<0.1**	**203**	478320-13
	Aberford Series (Site J1), Rutland, UK : L	**<0.1**	**85**	
	Malham Series (Site E), Derbyshire, UK: SL	**<0.1**	**381**	
	LUFA 5M, Kreis Rheim-Pfalz, Germany: SL	**<0.3**	**251**	
Aerobic Soil Metabolism (days)	Aberford Series (Site J1), Rutland, UK : L; EU Soil incubated for 4 months at 10 °C/40% **WHC**	**<1**	**184**	478320-13
Aerobic Soil Metabolism (days):	Aberford Series (Site J1), Rutland, UK : L; EU Soil sterilized/incubated for 4 months at 20 °C/ 40% of the **WHC**	**<1**	**NC**	478320-13
Soil Metabolism: Aerobic Phase (days)	CL Soil, Texas: 8 hrs under aerobic conditions then 113 d under anaerobic conditions @ 25 °C/35% of the **WHC**	**NC**	**NC**	478322-79
Anaerobic phase (days)		**NC**	**320**	
Soil Metabolism: Aerobic Phase (days)	Aberford Series (Site J1), Rutland, UK : L; 2 hrs under aerobic conditions & 120 d under anaerobic conditions @ 25 °C/40% of the **WHC**	**NC**	**NC**	478320-13
Anaerobic phase (days)		**NC**	**532**	
Aerobic Aquatic Metabolism (days for the total system): Pond water/sediment system, Derbyshire, UK (**system-1**)*	**Water:** pH 6.7 and dissolved organic carbon 6.2 ppm) and **Sediment:** sand (pH 6.3 and organic carbon 0.6%) incubated for 103 d @ 20 °C	**88**	**NC**	478320-14

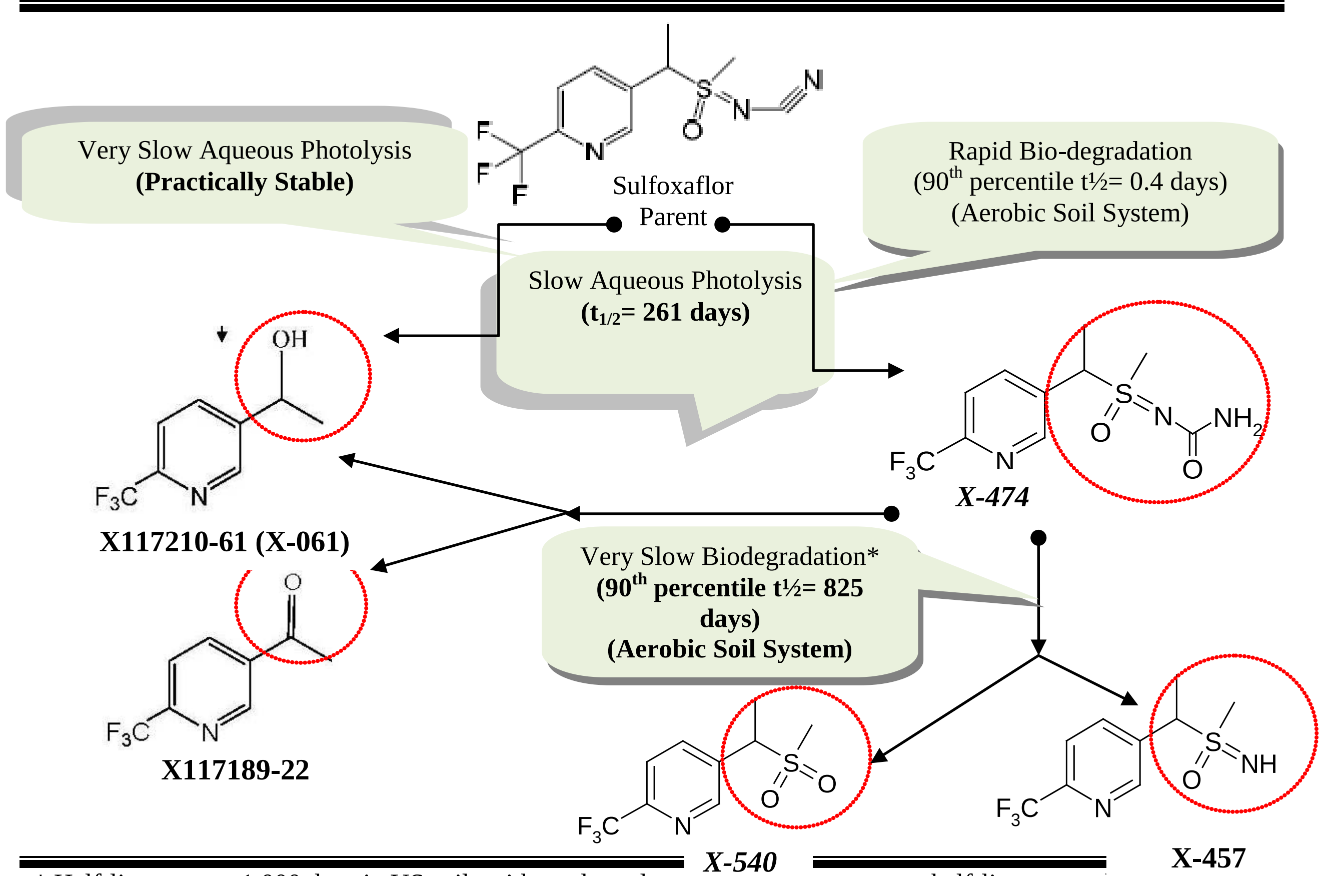
Property	Soil or Water/Sediment System*	*Half-life & (Fitting Equation)* Parent t½	X-464 t½	Reference (MRID)
Aerobic Aquatic Metabolism (days for the total system): Pond water/sediment system, Staffordshire, UK (**system-2**)*	**Water:** pH 7.8 and dissolved organic carbon 6.5 ppm) and **Sediment:** silt loam (pH 7.8 and organic carbon 3.9%) incubated for 103 d @ 20 °C	**37**	**NC**	
Anaerobic Aquatic Metabolism (days for the total system): Pond water/ sediment system, VA (**system-3**)*	**Water:** pH 7.5 and dissolved organic carbon 10.0 ppm) and **Sediment:** sand (pH 4.9 and organic carbon 0.2% incubated for 100 d @ 25 °C	**382**	**5,270**	
Anaerobic Aquatic Metabolism (days for the total system): Pond water/ sediment system, IA (**system-4**)*	**Water:** pH 7.8 and dissolved organic carbon 6.7 ppm) and **Sediment:** sandy clay loam (pH 7.3 and organic carbon 1.4%) incubated for 100 d @ 25 °C	**103**	**1,090**	473723-11

* **Abbreviations: NC**= Cannot be calculated due to gain or only few points is available; **Soil Textural Classes: CL**= Clay Loam; **L**= Loam Soil; **SL**= Sandy Loam Soil; and **LS**= Loamy sand; Data for aerobic systems from parent study while that for anaerobic systems from two separate studies: one for parent and the other for the major degradate X-474

Table 8. Parent degradation products for systems described in Table 7, above

Property	*Soil or Water/Sediment System*	*Parent Degradation Products (% of Applied)*	*Reference (MRID)*
Aerobic Soil Metabolism US soils **@** 25 °C/ 75% of the **WHC**	Lenawee light clay, MI Pullman light clay, TX Fayette clay loam, IA Slagle clay loam, VA	**Major (MAJ): X-474** (max. 98 to 99% by 14 to 31 days then decreased to 83-90% @ termination); **Minor (MIN):** None; **Mineralization (MRL): CO_2** (max. 1-3% @ termination); **Non-extractable residues (NER):** max. 7-13% @ termination	478655-78
Aerobic Soil Metabolism EU Soils @ 20 °C/ 40% of the **WHC**	Cranwell Series, UK Aberford Series, UK Malham Series, UK LUFA 5M, Germany	**MAJ: X-474** (max. 100% by day 1then decreased to 35-79% @ termination), and **X115795-40** (from 0 to 12%, formation time was variable "ranged from 4 to 81 days after incubation" with no clear decline; Data suggest net gain @ termination); **MIN: X115794-57**(from 0 to 9%, formation time was variable "ranged from 3 to 32 days after incubation" with no clear decline; Data suggest net gain @ termination); **MRL: CO_2** (max. 5-9% @ termination in all soils except Aberford Series with a max. of 28 to 32%); **NER:** max. 4-8% @ termination	478320-13
Aerobic Soil Metabolism	Aberford Series (Site J1), UK @ 10 °C/ 40% of the **WHC**	**MAJ:** X-474 (max. 97% within one day then declined to 68% @ termination); **MIN: X115794-57** (Max. 8% in 62 days decreasing to only 7% within the period from day 90 to termination); and **X115795-40** (Max. 8% within the period from 62-90 days decreasing to only 7% @ termination); **MRL:** CO_2 (max. 6% @ termination; **NER:** max. 9% @ termination	478320-13
Aerobic Soil Metabolism	Aberford Series (Site J1), UK sterilized then incubated @ 20 °C/ 40% of the **WHC**	**MAJ:** X-474 (max. 83% after 90 days then declined to 77% @ termination); **MIN:** None; **MRL:** CO_2 (max. <1% @ termination)**; NER:** max. 6% @ termination	478320-13
Aerobic/ Anaerobic Soil	Clay Loam Soil, TX**: Aerobic/Anaerobic Phases**	**MAJ:** X117194-74 (max. 95% after 20 days then declined to 75% @ termination); **MIN:** None; **MRL:** CO_2 (max. 0.45% @ termination); **NER:** max. 25% @ termination	478322-79

Property	*Soil or Water/Sediment System*	*Parent Degradation Products (% of Applied)*	*Reference (MRID)*
Metabolism	Aberford Series (Site J1), UK: **Aerobic/Anaerobic Phases**	**MAJ:** X117194-74 (max. 97 to 98% after 4 to 7 days then declined to 84% @ termination)**;** **MIN:** None; **MRL:** CO_2 (max. 0.1% @ termination)**;** **NER:** max. 12% @ termination	478320-13
Aerobic Aquatic Metabolism	**System 1:** Pond water/ sediment system , UK **System 2:** Pond water/ sediment system , UK	**MAJ:** X117194-74(max. ranging from 25 to 71% in system-1 and 47 to 66% in system-2 occurring at 61-103 days with no apparent decline); **MRL:** CO_2: max. 0.6 to1.5%, in systems 1 and 2, respectively, at study termination; **MIN:** max. 6 to 26% in systems 1 and 2, respectively @ termination	478320-14
Anaerobic Aquatic Metabolism	**System 3:** Pond water/ sediment system, VA **System 4:** Pond water/ sediment system, IA	**MAJ:** None; **MIN:** X-474 (max. 3% @ 14days in systems-3 and max. 8% @ study termination in system-4 (other replicate was only 3%); **MRL:** CO_2: <1% in systems-3 and 4 @ termination; **NER:** max.12 to 37% in systems-3 and 4, respectively @ termination	473723-11

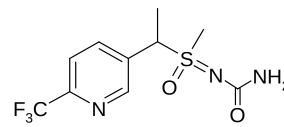
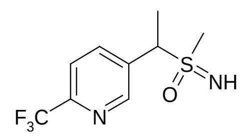
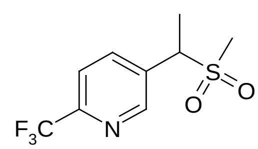
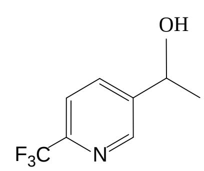
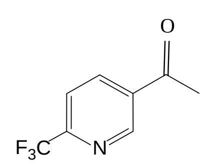


* Half-lives were >1,000 days in US soils with no degradates observed. In contrast, half-lives ranged from 85-381 days in EU soils producing degradate X-540 & X-457. Separate aerobic soil experiments showed that both of these degradates are persistent (90th percentile half-lives were 526 days (range 96 to 670 days) for X-457 and 2,808 days (range 71 to 3,630 days) for X-540

Figure 7. Expected environmental degradation pathways and transformation profiles for Sulfoxaflor

More details on laboratory biotic metabolism studies are included in **Appendix A**. Additionally, **Table 9** contains information about degradates of sulfoxaflor identified in varied biotic and biotic systems.

Table 9. Selected environmental degradates of sulfoxaflor

Characteristics	*Transformation Product*	*Structure*
Common Name	**X11719474 (X-474)**	
IUPAC	N-(methyl(oxido){1-[6-(trifluoromethyl) pyridin-3-yl]ethyl}-λ4-sulfanylidene) urea	
SMILES Code	c1c(ncc(c1)C(C)S(=NC(=O)N)(C)=O)C(F)(F)F	
Molecular Weight	297 g $mole^{-1}$	
Molecular Formula	$C_{10}H_{12}F_3N_3O_2S$	
Common Name	**X11579457 (X-457)**	
IUPAC	[5-[1-(S-methylsulfonimidoyl)ethyl]-2-(trifluoromethyl)pyridine	
SMILES Code	c1c(ncc(c1)C(C)S(=N)(C)=O)C(F)(F)F	
Molecular Weight	252.25 g/mole	
Molecular Formula	$C_9H_{14}F_3N_2OS$	
Common Name	**X11519540 (X-540)**	
IUPAC	5-(1-methanesulfonyl-ethyl)-2-trifluoromethyl-pyridine	
SMILES Code	c1c(ncc(c1)C(C)S(=O)(=O)C)C(F)(F)F	
Molecular Weight	253.24 g/mole	
Molecular Formula	$C_9H_{10}F_3NSO_2$	
Common Name	**X11721061 (X-061)**	
IUPAC	(1-[6-(trifluoromethyl)(2-14C)pyridin-3-yl]ethanol)	
SMILES Code	C1=CC(=NC=C1C(C)O)C(F)(F)F	
Molecular Weight	191.15	
Molecular Formula	$C_8H_8F_3NO$	
Common Name	**X11718922**	
IUPAC	1-(6-trifluoromethyl-pyridine-3-yl) ethanone	
SMILES Code	C1=CC(=NC=C1C(C)=O)C(F)(F)F	
Molecular Weight	189.14	
Molecular Formula	$C_8H_6F_3NO$	

c) Field Dissipation in Terrestrial Systems

Extensive data were collected from the terrestrial field dissipation (TFD) studies for sulfoxaflor (MRID 47832282). Complete analysis of the data is included in **Appendix A** and hereunder is a summary of these data. The terrestrial field dissipation (TFD) study for sulfoxaflor was designed based on the results of laboratory studies. These studies showed that sulfoxaflor degraded rapidly in soil, forming a major degradation product (X-474), and two minor degradation products (X-540 and X-457). Adsorption/desorption studies indicated that both parent sulfoxaflor and major/minor degradate (X-474, X-540 and X-457) are expected to be mobile. Additionally, sulfoxaflor and it degradate X-474 are systemic and were found to be stable to hydrolysis at pH 5, 7, or 9. Therefore, the TFD study design included leaching and plant uptake modules. Due to the low vapor pressure and Henry's law constant of sulfoxaflor, volatility in the field was not measured.

Five sites were selected for conducting bare and cropped-plots in California (CA), Florida (FL), North Dakota (ND), Ontario, Canada (ON), and Texas (TX). Sulfoxaflor soluble concentrate formulation (242 g active ingredient per litre of product or 22% w/w) was surface applied one to three times at nominal single rates ranging from 100g a.i./ha (equivalent to 0.089 lb a.i/A) to 200 g a.i./ha. The study design consisted of two treated plots (one cropped and one bare soil) and an untreated control plot at each study location (located at least 30 m from the treated plot). Treated and rotational crops representative of the geographical location of each test site were planted on areas designated for cropped plots over the course of the study. The California and Florida test sites were equipped with soil-suction lysimeters for the collection of soil-pore water samples. As required, supplemental irrigation (method not reported) was supplied to maintain at least 110% of long term average rainfall. The monthly target moisture input was set at 400% of the local historical average monthly precipitation in California and 120% in other sites. Other normal agronomic practices were followed.

Soil core samples were collected, for all sites, immediately after the first application to a depth of 6". Additionally, soil samples were collected from the soil profile to a depth of 36" at various sampling dates up to and including the end of the study (18 months in California, 15 months at other sites). The soil samples were extracted with 90:10 acetonitrile: 1.0 N hydrochloric acid (v: v) on a flat-bed shaker and extracts were concentrated prior to analysis. Soil pore-water samples were collected at depths of 3, 6, and 8 ft. in FL or 9 ft. in California at 1, 6, 13, 28 days and 2, 4, 6, 9, 12 and 15 months after the first treatment. Water samples were analyzed directly. Soil and water samples were analyzed for sulfoxaflor and its aerobic soil metabolite (X-474, X-540 and X-457) using HPLC) with positive-ion electrospray (ESI) tandem mass spectrometry (HPLC/MS/MS).

For at least one sampling event at each site, a set of transit stability samples were prepared to evaluate the stability of sulfoxaflor and its transformation products during shipment and storage. Soil samples were spiked at 1x and 100x the limit of quantification (LOQ= 0.001 ppm). Pore water samples were spiked at 1x and 40x the LOQ (0.05 ng/mL). Spiked samples were subjected to the same procedures as the field samples. Average recovery in transit stability soil samples ranged between 82 and 97% for sulfoxaflor, 94 and 125% for X-474, 77 and 101% for X-457, and 81.0 and 111% for X-540. Recovery in transit stability pore water samples was 88 % for

Sulfoxaflor, 95 and 88% for X-474, 85 and 84% for X-540, and 99 and 93% for X-457, in California and Florida, respectively.

Crop samples were collected at various crop growth stages during the first and second growing seasons and analyzed for sulfoxaflor, X474 (*i.e.*, the major soil metabolite)and X061 (*i.e.*, the plant metabolite) using a reverse-phase polymeric solid-phase extraction (SPE) cartridge on-line system using HPLC/MS/MS. The Method of Analysis limits of Detection/Quantification LOD/ LOQ and Performance were reported and were within acceptable limits. In addition application was verified by tank mix data, Soil deposition trays/saturated pads and zero-time concentrations.

A summary of the TFD Half-lives for parent Sulfoxaflor is included in **Table 10**.

Table 10. Field dissipation half-lives (DT50 in days) for sulfoxaflor from the top 6" of the soil and the entire soil profile (0-36")

		CALIFORNIA*		***FLORIDA****		***NORTH DAKOTA****		***ONTARIO****		***TEXAS****	
Chemical	***Considered Depth***	***Bare***	***Cropd***	***Bare***	***Cropd***	***Bare***	***Cropd***	***Bare***	***Cropd***	***Bare***	***Cropd***
Sulfoxaflor Parent	0-6" (top soil)	**2.0**	**1.9**	**0.7**	**1.6**	**0.3**	**0.1**	**0.6**	**0.9**	**8.1**	**1.5**
	0-36" (entire profile)	**ND**	**ND**	**ND**	**ND**	**ND**	**0.2**	**0.6**	**ND**	**8.1**	**1.5**

Bare= Bare soil plots; ***cropd***= cropped plots; **ND**= Not determined due to lack of data

Field leaching was also tested using soil pore water suction lysimeters to collect soil-pore water samples in two of terrestrial field dissipation studies: CA and FL. soil-suction lysimeters were installed at sampling depths of 3, 6, and 8 (FL) or 9 (CA) feet below ground surface. Soil-pore water samples were collected at -1, 6, 13, 28 days and 2, 4, 6, 9, 12 and 15 months after the first treatment. Although sulfoxaflor was not detected in pore water at any time/depth sampled in the high leaching profile in CA, it was concluded that non-detection was related to time of sampling rather than absence of leaching (*i.e.*, samples missed the leaching events).

Consistent with laboratory studies, major degradate X-474 was the major transformation product in the field dissipation studies. Data for the top 6" of the soil indicate the rapid formation of X-474 as its concentration of 13-54% of the applied parent was observed immediately following the first application. This was the case also following the second and third applications in CA and FL sites. Furthermore, data suggest that X-474 has the potential to carryover especially if leaching is limited (concentrations ranging from 1 to 18% of the applied parent were left in the soil after a year). Dissipation half-lives (DT_{50}) for X474 were calculated for residues in the top 6" of the soil and the whole 0-36" soil profile following the same procedure described for above for parent. Results are summarized in **Table 11**.

Table 11. Field dissipation half-lives (DT50) for major degradate X-474 from the top 6" of the soil and the entire soil profile (0-36")

Chemical	Considered Depth	CALIFORNIA*		FLORIDA*		NORTH DAKOTA*		ONTARIO*		TEXAS*	
		Bare	Cropd	Bare	Cropd	Bare	Cropd	Bare	Cropd	Bare	Cropd
X-474 Degradate	0-6" (top soil)	**27**	**52**	**49**	**62**	**217**	**40**	**248**	**109**	**51**	**58**
	0-36" (entire profile)	**6**	**10**	**49**	**60**	**200**	**36**	**114**	**59**	**45**	**52**

Bare= Bare soil plots; ***cropd***= cropped plots; **ND**= Not determined due to lack of data

Data summarized in **Table 11** indicate that X-474 is much more persistent than its parent. Dissipation half-lives ranged from 49 to 248 days and from40 to 109 days in bare soil and cropped plots, respectively. Additionally, X-474 leached below the top 6" soil layers at all terrestrial field dissipation sites reaching 36, 30, 24, and 18" below the surface. At CA and FL sites, residues of X474 reached a depth of 36" with maximum concentrations of 19.5 to 20.6 ppb (≈19-20% of the applied parent) at 28 days after the 1st application in CA and maximum concentrations of 1.7 to 2.5 ppb (≈2-4% of the applied parent) at 2-15 months after the 1st application in FL. In ND, X-474 reached a depth of 30" with maximum concentrations of 1.0 to 2.3 ppb (≈2-4% of the applied parent) at 2-11 months after the 1st application. At ON (Canada) site, it reached a depth of 18" with maximum concentrations of 0.5-1.6 ppb (≈0.6-10% of the applied parent) at 9 months after the 1st application. At TX site, it reached a depth of 12" below the soil surface with maximum concentrations of 14.7 to 17.5 ppb (≈18-22% of the applied parent) at 4-9 months after the 1st application. Observed data confirm that field dissipation of X-474, from the top soil, is mainly related to transport (K_{oc}= 7 to 74 mL/g) rather than degradation.

Other Degradates: X-540 and X-457 were minor transformation products in the field. In most field sites, the two degradates dissipated from the 0-6 inch soil layer before the end of the study. The observed formation of minor quantities of degradates X-457 and X-540 is probably related to the relative high persistence of its most probable parent (the major degradate X-474). A kinetic analysis was not performed for X-540 and X-457.

Crop residue results for all five test sites were monitored for parent sulfoxaflor and its major transformation product X-474, as well as X-061 (a plant metabolite). Field plant data can be used to characterize foliage interception/uptake of applied parent and nature/concentration of residues in target and rotational crops. Other data were collected on nature and concentration of residues in target and rotational crops and summary/analysis of this data are included in **Appendix A**.

Top soil carryover is not expected for sulfoxaflor parent but is expected for X-474, X-457 and X-540. Estimated carryover for all of the three degradates were minimal (0-<1%) for CA site while it was significantly higher for FL, ND, ON and TX sites. For X-474, the maximum top soil carryover is estimated to be 15% for FL, 39% for ND, 40% for ON and 46% for TX. This is a reflection of the high formation/persistence of the degradate X-474. For X-540, the maximum top soil carryover is estimated to be 1% for FL, 4% for ND, 3% for ON and 5% for TX. For X-457, the maximum top soil carryover is estimated to be <2% in FL, ND, ON and TX.

d) *Mobility*

Laboratory adsorption data for sulfoxaflor indicate that the chemical can be characterized by very high to high mobility based on Freundlich organic carbon-based adsorption (K_{foc} ranged from 11-72 mL g^{-1} with an average of 35 mL g^{-1} and a median value of 31 mL g^{-1}). However, rapid degradation in soil is expected to limit the amounts of the chemical that may potentially leach and contaminate ground water. Contamination of groundwater by sulfoxaflor will only be expected when excessive rain occurs within a short period (few days) of multiple applications in vulnerable sandy soils.

Adsorption/desorption properties of parent sulfoxaflor and three of sulfoxaflor degradates were examined in seventeen soils for parent and X-474, seven soils for X-457 and six soils for X-540. Results for the adsorption phase are summarized in **Table 12** along with soils characteristics and locations.

Table 12. Transport properties Sulfoxaflor and its degradates

	K_{foc} For Parent & Degradates L/Kg [1]				***T; S; Si & C= Texture; Sand; Silt & Clay*** [2]						
Soil: Geographic Location	***Parent***	***X-74***	***X-57***	***X-40***	***T***	***S%***	***Si%***	***C%***	***pH***	***% OC***	***CEC***
Lenawee: MI, USA	31	24	44	20	CL	31	35	34	5.9	1.8	16.9
Pullman-1: TX, USA	47	40	23	24	CL	31	34	35	6.9	1.2	23.2
Fayette: Iowa, USA	50	50	26	25	L	34	47	19	6.3	1.1	14.3
Slagle: VA, USA	34	21	35	ND	SL	54	30	16	6.4	1.0	5.0
M773: CA, USA	55	76	ND	ND	S	86	13	1	6.3	0.3	3.2
M774: FL, USA	53	31	ND	ND	LS	86	8	6	6.2	0.8	4.3
Bearden-Lindaas: ND, USA	72	68	ND	ND	C	17	32	51	7.9	1.8	36.0
Pullman-2: TX, USA	46	45	ND	ND	CL	27	38	35	6.7	1.1	21.5
Lacustrine: ON, Canada	29	23	ND	ND	L	31	46	23	6.9	1.8	8.9
Cranwell, Site I: Lincolnshire, UK	21	13	11	1	LS	81	16	3	7.6	1.3	9.2
Aberford, Site J1: Rutland, UK	12	7	2	6	L	49	32	19	7.3	6.7	37.9
Malham, Site E: Derbyshire, UK	11	8	10	6	SiL	28	59	13	6.2	3.5	20.3
LUFA 5M: Kreis Rheim-Pfalz, Germany	24	19	ND	ND	SL	61	26	13	7.4	1.2	6.3
M775: Bologna, Italy	31	32	ND	ND	SCL	54	23	23	7.4	1.3	13.2
M776: Valencia, Spain	30	22	ND	ND	CL	42	30	28	7.8	1.2	9.8
M780: Haine-Et-Loire, France	20	14	ND	ND	CL	43	24	33	7.8	1.7	15.6
M781: Lower Saxony, Germany	23	18	ND	ND	SL	19	62	19	6.3	1.1	10.0
Average Values	**35**	**30**	**22**	**14**							
Median Values	**31**	**23**	**23**	**13**							

[1] Degradates: ***X-74***= X11719474; ***X-57***= X11579457; ***X-40***= X11519540; ND= Not determined
[2]CL= Clay Loam; L= Loam; SL= Sandy Loam; S= Sand; LS= Loamy Sand; C= Clay; SiL= Silt Loam; SCL= Sandy Clay loam

Data for Freundlich organic carbon based adsorption (K_{foc}; **Table 12**) indicates that parent sulfoxaflor and it degradates are expected to be highly mobile to mobile in soil systems (FAO, 2000)[5]. One desorption cycle was carried out for parent sulfoxaflor and transformation products were not subjected to the desorption step. Freundlich desorption isotherms (K_f) ranged from 0.18 to 0.89 (K_{foc} of 9-61 suggesting that parent sulfoxaflor will not bind irreversibly and that some material will desorb from the soil.

e) Environmental Chemistry Methods and Independent Laboratory Validation

Table 13 contains a summary of the analytical methods to be used for determining concentrations of parent sulfoxaflor and degradates in soil, water, and air. The limit of quantification established for each method/analyte is also included in the same Table.

Table 13. Summary of analytical methods (residue) for soil, water and air (method type for all analytes= LC/MS/MS)

Method ID	*LOQ (For All Analytes)*	*Reference MRID*
Soil (Analytes: Sulfoxaflor, X11519540 (X-540), X11579457 (X-457) and X11719474 (X-474)		
(1) Dow AgroSciences Study Number 091185	0.001 mg/kg	47832269
(2) Dow AgroSciences Study Number 101100	0.001 mg/kg	47832256
(3) Pyxant Labs Inc. Study Number 081078-1906A	0.001 mg/kg	47832270
Water (Analytes: Sulfoxaflor, X11519540 (X-540), X11579457 (X-457) and X11719474 (X-474)		
(1) Dow AgroSciences Study Number 091186	0.05 µg/L (with SPE); 0.25 µg/L (without SPE)	47832268
(2) Dow AgroSciences Study Number 101650	0.05 µg/L (with SPE)	47832267
(3) Pyxant Labs Inc. Study Number 081078-1906B	0.05 µg/mL	47832266
Air		
Not reviewed; not required for registration in the United States; Not expected to partition into the air.		47832265

The soil method is applicable for the quantitative determination of residues of Sulfoxaflor and its metabolites (X-540, X-457, and X-474) in soil (MRID 47832269). Validation was conducted using four soil types; the soil textural classifications were silt loam, sandy loam, clay loam, and loam. The method was validated over a concentration range of 0.001-1.0 mg/kg with a validated limit of quantitation of 0.001 mg/kg and limit of detection of 0.0003 mg/kg (MRIDs 37832256 and 47832270). The mean recovery for fortified control samples was within the acceptance

[5] Food and Agriculture Organization of the United Nations (FAO), 2000. FAO pesticide disposalseries 8. Assessing soil contamination: A reference Manual. Appendix 2. Parameters of pesticides that influence processes in the soil. Editorial Group, FAO Information Division, Rome.

range of 70-110% with a relative standard deviation (RSD) of $\leq$20% with one exception. The average recovery for X-540 at the 0.010-mg/kg level was 113%; however, the data was considered valid as RSD was less than 6% for 29 replicates.

The water method is applicable for the quantitative determination of residues of sulfoxaflor and its metabolites (X-457, X-540, and X-474) in drinking water (tap water), ground water (well water), and surface water (pond water) (MRID 47832268). The method was executed with and without a solution purification step using an online reverse-phase polymeric solid-phase extraction (SPE) cartridge. The method was validated over a concentration range of 0.050-50.0 µg/L (MRID 47832267) with a validated limit of quantitation was:

- 0.050 µg/L when the SPE step is included; and
- 0.250 µg/L when the SPE is not included

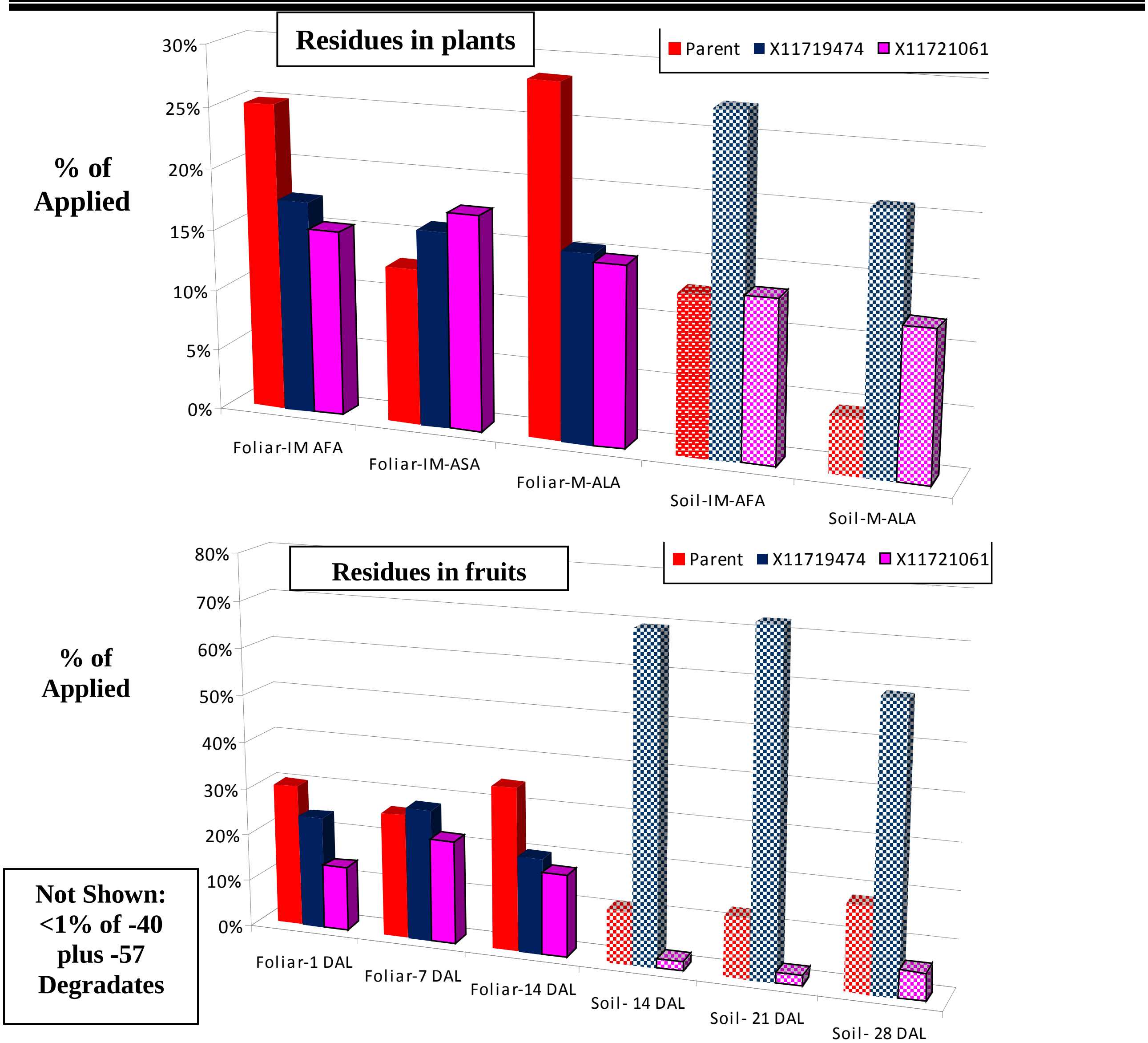
The mean recovery for fortified control samples was within the acceptance range of 70-110% with a relative standard deviation (RSD) of $\leq$20%.

For ground water (pore water), the method is applicable for the quantitative determination of residues of sulfoxaflor, and its major metabolites (X-457, X-540, and X-474) in ground water (soil pore). The method was validated over a concentration range of 0.050-2.00 µg/L with a validated limit of quantitation of 0.050 µg/L (MRID 47832266).

f) Metabolism, Distribution and Expression of Residues in Plants

Sulfoxaflor is a systemic pesticide; therefore it is important to analyze available plant data toward understanding how exposure pathways may be affected by plants. A study was conducted, on tomato plants, where ^{14}C sulfoxaflor was foliarly applied in one experiment and was soil applied in another[6]. In the foliar application experiment, the chemical was applied four times/directly into foliage at a seasonal total of 600 g a.i/ha. In the soil application experiment, ^{14}C-sulfoxaflor was applied twice/directly into the soil at a seasonal total rate of 400 g a.i/ha. A summary of the data for both experiments are included in **Figure 8**.

[6] Rotondaro, S. L., Balcer, J. L., and Smith, K. P. A Nature of the Residue Study with 14C-SULFOXAFLOR Applied to Tomatoes, Unpublished report of Dow AgroSciences, study ID 070021, 22 February 2010, amended 24 March 2010.



Foliar/Soil= foliar "solid columns"/soil application "hatched columns"; **IM/M**= immature/mature plants; **AFA/ASA/ALA**= after $1^{st}/2^{nd}$/Last Application; **DAL**= days after last application
Chemical source: Foliar= from Foliar applied parent; Soil= from Soil applied parent

Figure 8. Distribution of sulfoxaflor residues in tomato following foliar and soil applications

As shown in **Figure 8**, the majority of the radioactive residue in the foliar-applied tomato plants was identified as parent followed by two degradates: X117194-74 and X117210-61. Plant metabolism appears to produce the two degradates in parallel from parent and in sequence from parent to X-474 to X-061. It is noted that reported aerobic soil metabolism data (elsewhere in this document) show that degradate X-474 is the major aerobic soil degradate of sulfoxaflor while X-061 is not a product of this route of degradation. In this foliar experiment, the only source of sulfoxaflor is foliage as it was not applied to soil. Presence of sulfoxaflor and degradates X117194-74 and X117210-61 in the plant, suggest that parent sulfoxaflor entered the plant from foliage and was subjected to plant metabolism producing degradates X-474 and X-061. Therefore, both of these degradates can be considered as plant metabolism degradates.

In contrast to foliage, the majority of the radioactive residues in the tomatoes proper were identified as the degradate X-474 followed by substantially lower concentrations of parent and X-061 (**Figure 8**). The noticeable increase of X-474 in tomato foliage suggests the presence of an additional source for X-474 (*e.g*., root uptake from soil). It appears that sulfoxaflor parent was subjected to three parallel processes: movement into plant as parent (source of parent in the plant), degradation in the soil producing X-474 that also appear to move into the plant via root uptake, plant metabolism (reducing parent concentration entering the plant with production of additional amounts of X-474 in addition to X-061). In the plant, the combined results of these three processes are high X-474 concentration (movement from soil plus production in plant) and low concentration of. These residue studies suggest that similar to the parent, X-474 is systemic and that it can be produced by soil and plant metabolism.

Equivalent metabolism studies were executed for succulent peas[7], three foliar applications, a total of 601 g a.i./ha; and two soil applications, totaling 434 g a.i./ha), lettuce (MRID ?[8], three foliar, one on immature plants and two on mature plants, totaling 599 g a.i./ha along with one soil application at a rate of 454 g a.i./ha) and rice[9], three foliar application, totaling 578 g a.i./ha along with one soil application at a rate of 474 g a.i./ha). Maximum observed concentrations for sulfoxaflor parent and degradates are summarized in **Figure 9** for all studies including tomatoes.

[7] Hastings, M. J., Rotondaro, S. L., and Balcer, J. L. A Nature of the Residue Study with [14C]-XR-208 Applied to Peas, Unpublished report of Dow AgroSciences, study ID 070035, 13 May 2010.
[8] Graper, L. K., Balcer, J. L., and Smith, K. P. A Nature of the Residue Study with [14C]-XDE-208 Applied to Lettuce, Unpublished report of Dow AgroSciences, study ID 070033, 01 June 2010.
[9] Rotondaro, S. L., Balcer, J. L., and Smith, K. P. A Nature of the Residue Study with 14C-XDE-208 Applied to Rice, Unpublished report of Dow AgroSciences, study ID 070034, 23 December 2009, amended 13 January 2010 and 24 March 2010.

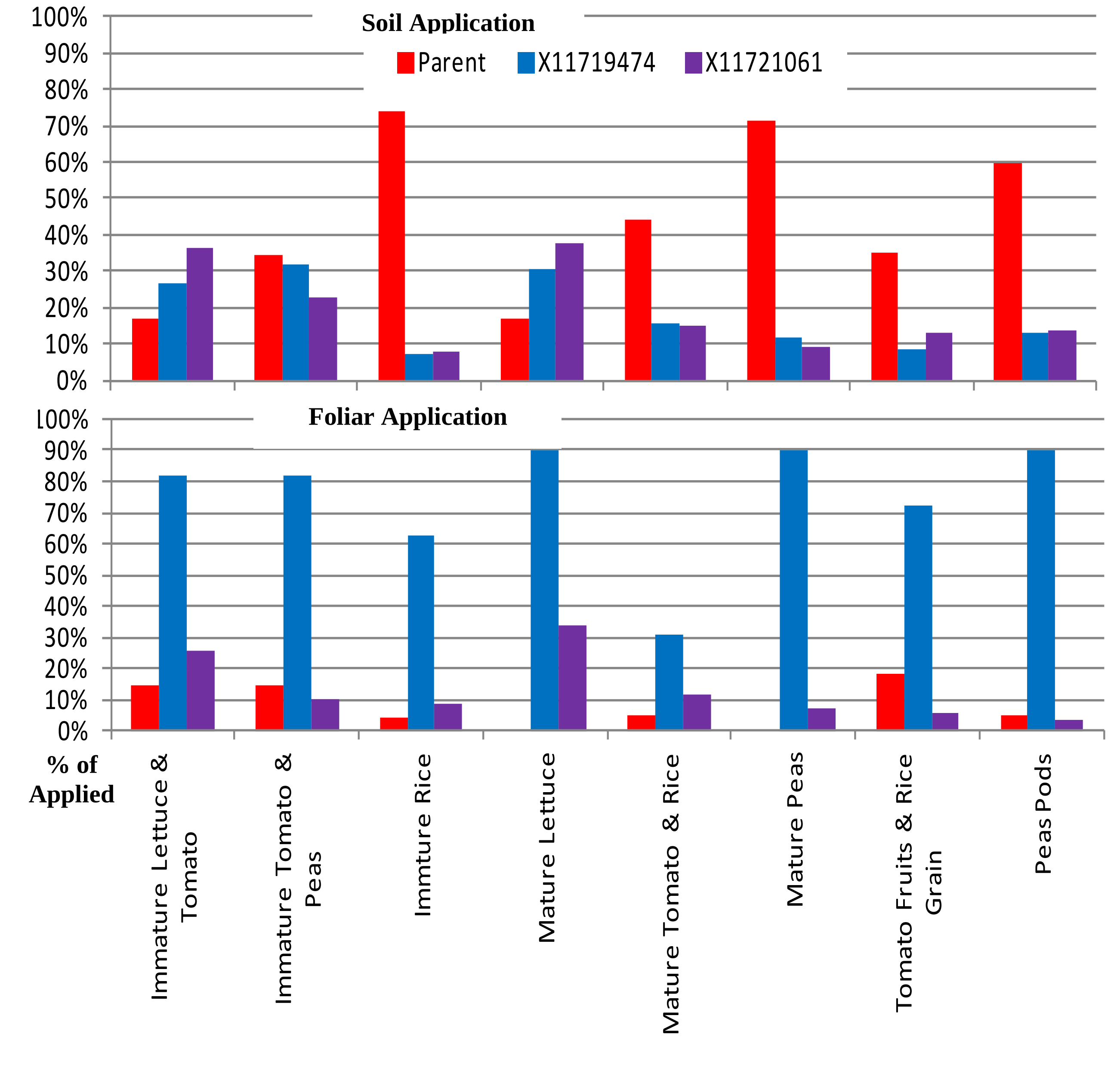


Figure 9. Distribution of maximums of sulfoxaflor residues in four crops following foliar and soil applications

Data depicted in **Figure 9** indicate that when sulfoxaflor is applied to foliage it enters immature plants giving varied maximum concentrations (rice> tomatoes& peas> lettuce). In contrast, only limited sulfoxaflor parent enters the plant before it degrades into X-474 which appears to be what enters the plants giving relatively high concentrations (over 60% with tomato, lettuce & peas> rice). The level of "soil originated parent sulfoxaflor" that enters the plant is relatively low due to the fact that parent is not expected to be available in the soil system due to its rapid degradation. As plants mature, tissues appear to retain "foliage originated parent sulfoxaflor" at the same level in peas, lower level in rice and at higher level in tomato. In fruits, grain and pods, the level of “foliar originated parent sulfoxaflor” is maintained with concentration ranging from 30 to 60%. “Soil originated X-474” appear to show similar patterns to its parent with relatively higher concentrations. Plant metabolism of foliage or soil originated parent and degradate X-474 appears to be occurring at all stages of plant development producing X-061 and other degradates. The pattern of formation and decline for parent and degradate is difficult to deduce due to the apparent occurrence of multiple processes including degradation and translocation; within the plant and from soil/foliage to plant.

When sulfoxaflor is applied foliarly on growing crops it is intercepted by the crop canopy. Data presented above appear to indicate that sulfoxaflor enters the plant and is incorporated in the plant foliage with only limited degradation. It appears that this is the main source of the insecticide sulfoxaflor that would kill sap sucking insects. This is because washed-off sulfoxaflor, that reaches the soil system, is expected to degrade rapidly to the main degradate X-474 (aerobic soil $90^{\%tile}$ $t_{½}$= 0.4 day). Additionally, plant data suggest that the degradate X-474 is systemic as well and is expected to enter the plant from the soil. No data were presented on the insecticidal activity of this degradate.

g) Expected Behaviour of Sulfoxaflor in an Agricultural Setting

Sulfoxaflor is proposed for application to variable density foliage of growing crops that depends on the timing of application (in all crops, the application window spans from seedlings to harvest). Upon application, only limited quantities of the pesticide are expected to be carried away by drift (to adjacent terrestrial and aquatic systems) with the majority being deposited on target plants. Additionally, part of the applied pesticide is deposited into the soil with amounts being dependent on treated crop foliage density and wash-off from foliar surfaces.

Sulfoxaflor deposited on the plant foliage is available for plant uptake. Plant residue data indicate that the parent compound enters the plant and is distributed into the foliage with only limited degradation (depending on the plant). The same data also suggest that the degradate X-474 is systemic and can enter the plant from the soil (following its formation from rapid parent degradation). Parent entering the plant through foliage and X-474 entering the plant from soil may be a source of exposure depending on the agricultural practices. In contrast, sulfoxaflor, reaching the soil system directly and/or from foliage wash-off, will be subjected to rapid degradation to X-474 (main soil degradate) which further degrades in most soils very slowly producing relatively low concentrations of X-540 and X-457.

h) Fish Bioconcentration

No Fish bioconcentration study was submitted due to the low K_{ow} (K_{ow} @ 20 C & pH 7= 6; Log K_{ow} = 0.802). Based on the low K_{ow}, sulfoxaflor is not expected to bioaccumulate in aquatic systems. Although the parent compound has a high K_{OA} which signifies a potential for bioaccumulation in terrestrial ecosystems, sulfoxaflor is not expected to move into the air in appreciable concentrations based on its physical-chemical properties.

3.2.2. Measures of Aquatic Exposure

Aquatic exposures are quantitatively estimated for all of assessed uses using scenarios that represent high exposure sites for sulfoxaflor use. Each of these sites represents a 10-hectare field that drains into a 1-hectare pond that is 2 meters deep and has no outlet. Exposure estimates generated using the standard pond are intended to represent a wide variety of vulnerable water bodies that occur at the top of watersheds including prairie pot holes, playa lakes, wetlands, vernal pools, man-made and natural ponds, and intermittent and first-order streams. As a group, there are factors that make these water bodies more or less vulnerable than the standard surrogate pond. Static water bodies that have larger ratios of drainage area to water body volume would be expected to have higher peak EECs than the standard pond scenario. These water bodies will be either shallower or have large drainage areas (or both). Shallow water bodies tend to have limited additional storage capacity, and thus, tend to overflow and carry pesticide in the discharge whereas the standard pond has no discharge. As watershed size increases beyond 10 hectares, at some point, it becomes unlikely that the entire watershed is planted to a single crop, which is all treated with the pesticide. Headwater streams can also have peak concentrations higher than the standard pond, but these higher concentrations tend to persist for only short periods of time and are then carried downstream.

The objectives of this approach are to determine the EECs for the total toxic residues (TTR) of parent sulfoxaflor which represent the stressor of concern in aquatic systems. Based on the toxicity of parent sulfoxaflor and important degradates, *i.e.*, X-474 and X-540 to aquatic organisms, only parent and X-540 are considered in estimating the EECs of the stressor.

However exposure is dominated by the degradate X-474 and in order to understand the exposure of parent and its degradation products, EECs for parent and each of the individual constituents of the parent residues, namely, parent, X-474, and X-540 were also estimated by running the following simulations:

a. Residues of interest runs for scenarios representing all crop use patterns with ground and aerial application (a total of 50 runs using EXPRESS graphical interface);
b. Residues of interest runs for scenarios representing all crop use patterns with aerial application; varied first application dates "5-15 runs through the long application window for this chemical" (using PE-5 graphical interface);
c. Residues of interest runs for the same scenarios including two runs: one with drift and the other without drift (using PE-5 graphical interface); and
d. Parent alone runs for the same scenarios (using PE-5 graphical interface).

Hereunder, is a complete list of the steps taken to perform modeling:

(1) ***Model Runs Residues of Interest and Parent (all Crops Except Watercress)***

a. Inputs Used for Modeling

The first set of input parameters needed for modeling is labeled application parameters for various use patterns. Currently suggested labeled application parameters for sulfoxaflor are summarized in **Table 14**.

Table 14. Crop use patterns proposed for sulfoxaflor (Ground or aerial is permitted for all uses (refer to exceptions stated below this Table for Turf and ornamentals)

Crop/Crop Group	*Crop Group(CG) Or Subgroup (SG)*	*Application Parameters: Maximum Application Rates/ Number& Minimum Intervals (Days) & Window*				
		*Single (lb a.i./A)**	*Number*	*Yearly (lb a.i./A)**	*Intervals*	*Window***
Beans	Beans	0.090	3			**For crops:** from date of seedling to pre-harvest taking into consideration the pre-harvest interval (PHI) for each crop PHI ranges from 1 to 14 days) **For trees:** from Pre-bloom to mature fruit
Berries	SG 13-07F &G	0.090	3	0.266	7	
Canola (Rapeseed)	SG 20A	0.043	2	0.090	14	
Citrus	CG 10	0.133	2		7	
Cotton	Cotton	0.090	3		5	
Fruits: Pome	CG 11	0.133	2		7	
Fruits: Stone	CG 12	0.133	2	0.266	7	
Grains (small grains)	Small Grains	0.043	2	0.090	14	
Ornamentals	Ornamentals	0.133	2			
Soybeans	Soybeans	0.090	3			
Tree Nuts	CG 14 & Pistachio	0.133	2			
Turf grass	Turf grass	0.133	2			
Vegetables: Brassica (cole) leafy	CG 5	0.090	3			
Vegetables: Bulb	SG 3-07	0.090	3			
Vegetables: Cucurbit	CG 9	0.090	3			
Vegetables: Fruiting & Okra	CG 8 & Okra	0.090	3			
Vegetables: Leafy except Brassica	CG 4	0.090	3			
Vegetables: Root & tuber /Leaves	CG 1 & 2	0.090	3			
Watercress (commercial production)	Watercress	0.090	3	0.266	7	

Exceptions: (1) Only to commercial sod farms and grass grown for seed applied only by ground; and
(2) May be applied aerially only to commercially grown ornamentals

* Application rates entered into PRZM/EXAMS modeling are in Kg/ha= lbs/A multiplied by 1.121. For example: the maximum single application rate for beans= 0.09 x 1.121= 0.101 kg/ha and the yearly rate= 0.266 x 1.121= 0.298 kg/ha

** * Expected application date: This date is the date giving the highest EEC among multiple dates within the labeled application windows: from pre-bloom to mature fruits for trees and from seeding to harvest for all others. Starting and ending dates for windows were taken from the scenarios. Multiple runs were executed for each scenario with dates of application The number of runs executed for each scenario. Actual application dates chosen for various scenarios are included in **Appendix A**.

The second set of input parameters needed for modeling involves choosing crop scenarios to represent the proposed use patterns. All available standard scenarios were used for modeling to represent labeled crop use patterns. A list of these scenarios along with the required application parameters is presented in **Table 15**.

Table 15. List of scenarios and application parameters used in modeling

Crop/Crop Group	*Crop(s)*	*Scenario*	*Application Parameters (No.= Number of Applications)* Rate (lb a.i/A) X No.[1]	Intervals (Days)
Beans	Beans (dry & Lima, snab)	MIbeansSTD	0.090 x 3	7
Beans	Beans (dry & Lima, snab)	ORsnbeansSTD	0.090 x 3	7
Berries	Berries & Strawberry	FLstrawberrySTD*	0.090 x 3	7
Canola (Rapeseed)	Rape seed	NDcanolaSTD	0.043 x 2	14
Canola	mustard greens	FLcabbageSTD	0.043 x 2	14
Canola	Sesame	CAcottonSTD*	0.043 x 2	14
Canola	Sesame	MScottonSTD	0.043 x 2	14
Canola	Sesame	MSsoybeanSTD	0.043 x 2	14
Canola	Sesame	NCcottonSTD	0.043 x 2	14
Citrus	Citrus	FLcitrusSTD	0.133 x 2	7
Citrus	Citrus	CAcitrusSTD*	0.133 x 2	7
Cotton	Cotton	NCcottonSTD	0.090 x 3	5
Cotton	Cotton	MScottonSTD	0.090 x 3	5
Cotton	Cotton	CAcottonSTD*	0.090 x 3	5
Fruits: Pome & Stone	Apples, Peaches & Cherries	CAfruitSTD*	0.133 x 2	7
Fruits: Pome	Apples, pears & Quince	NCappleSTD	0.133 x 2	7
Fruits: Pome	Apples, pears & Quince	ORappleSTD	0.133 x 2	7
Fruits: Pome	Apples, pears & Quince	PAappleSTD_V2	0.133 x 2	7
Fruits: Stone	Peaches &/Or Cherries	GAPeachesSTD	0.133 x 2	7
Fruits: Stone	Peaches &/Or Cherries	MICherriesSTD	0.133 x 2	7
Grains (small grains)	Barley, Triticale & Wheat	NDwheatSTD	0.043 x 2	14
Ornamentals	X-mass Trees	ORXmasTreeSTD	0.133 x 2	7
Ornamentals	Ornamentals	CAnurserySTD_V2	0.133 x 2	7
Ornamentals	Ornamentals	MInurserySTD_V2	0.133 x 2	7
Ornamentals	Ornamentals	NJnurserySTD_V2	0.133 x 2	7
Ornamentals	Ornamentals	FLnurserySTD_V2	0.133 x 2	7
Ornamentals	Ornamentals	TNnurserySTD_V2	0.133 x 2	7
Soybean	Soybean	MSsoybeanSTD	0.090 x 3	7
Tree Nuts	Almonds	CAalmondSTD*	0.133 x 2	7
Tree Nuts	Filberts	ORfilbertsSTD	0.133 x 2	7
Tree Nuts	Pecans	GAPecansSTD	0.133 x 2	7
Turf grass	Turf	FLturfSTD	0.133 x 2	7
Turf grass	Turf	PAturfSTD	0.133 x 2	7

Crop/Crop Group	*Crop(s)*	*Scenario*	*Application Parameters (No.= Number of Applications)*	
			Rate (lb a.i/A) X No.[1]	*Intervals (Days)*
Vegetables: Brassica (cole) Leafy	Several **	FLcabbageSTD	0.090 x 3	7
Vegetables: Bulb	Onion (dry/green) & Pearl	CAonionSTD*	0.090 x 3	7
Vegetables: Bulb	Onion (dry/green) & Pearl	GAOnionSTD*	0.090 x 3	7
Vegetables: Cucurbit	Cucumber, Melons	NJmelonSTD	0.090 x 3	7
Vegetables: Cucurbit	Cucumber, Melons	MOmelonSTD	0.090 x 3	7
Vegetables: Cucurbit	Cucumber, Melons	MImelonSTD	0.090 x 3	7
Vegetables: Cucurbit	Cucumber, Melons	FLcucumberSTD	0.090 x 3	7
Vegetables: Fruiting & Okra	Pepper	FLpeppersSTD	0.090 x 3	7
Vegetables: Fruiting & Okra	Tomato, Eggplant & Okra	PAtomatoSTD	0.090 x 3	7
Vegetables: Fruiting & Okra	Tomato, Eggplant & Okra	FLtomatoSTD	0.090 x 3	7
Vegetables: Fruiting & Okra	Tomato, Eggplant & Okra	CAtomatoSTD*	0.090 x 3	7
Vegetables: Leafy	Parsley	ORmintSTD	0.090 x 3	7
Vegetables: Leafy except Brassica	Lettuce/Celery/ Spinach	CAlettuceSTD	0.090 x 3	7
Vegetables: Root & tuber	Carrot & Burdock (edible)	FLcarrotSTD	0.090 x 3	7
Vegetables: Root & tuber	Potatoes, Turnip& Rutabaga	MEpotatoSTD	0.090 x 3	7
Vegetables: Root & tuber	Potatoes, Turnip& Rutabaga	IDNpotatoSTD*	0.090 x 3	7
Vegetables: Root & tuber	Sweet Potatoes	NCSweetPotatoSTD	0.090 x 3	7
Vegetables: Root & tuber	Beet & Ginseng	MNsugarbeetSTD	0.090 x 3	7

[1] Application rates entered into PRZM/EXAMS modeling are in Kg/ha= lbs/A multiplied by 1.121. For example: the maximum single application rate for beans= 0.09 x 1.121= 0.101 kg/ha and the yearly rate= 0.266 x 1.121= 0.298 kg/ha
* Scenarios with irrigation
** including: Broccoli, Brussels sprouts, Cabbage, Cauliflower, Kale

The third set of input parameters needed for modeling is the fate and transport characteristics of the chemicals being modeled. These parameters are summarized in **Table 16** for the residues of interest and ***parent*** runs.

Table 16. Summary of PRZM/EXAMS input parameters for modeling Sulfoxaflor parent and residues of interest

Input Parameter (Unit)	*Value for Residues of Interest* (Parent)*	*Reference (MRID No) and Notes*
Molecular Weight g/mole	277.27 (for both)	Product chemistry
Henry's constant (atm-m^3 mol^{-1} *@ 25 ^oC)*	1.2×10^{-11} (for both)	Calculated

Input Parameter (Unit)	*Value for Residues of Interest* (Parent)*	*Reference (MRID No) and Notes*
Solubility in Water(mg/L)	570 (for both)	Product chemistry
Photolysis in Water (t½ in days @ pH 7)	Stable (for both)	Because the only photolysis degradate is included **(MRID 478322-83)**
Aerobic Soil Metabolism (90^{th} % t½ in days)	1,502 (0.4)	**(MRIDs 478655-78 and 478320-13)**
Hydrolysis (90^{th} % t½ in days)	Stable (for both)	**(MRID 478321-49)** All degradates are considered stable
Aerobic Aquatic Metabolism (90^{th} % Whole system t½ in days)	1,577 (141)	**(MRID 478320-14)**
Anaerobic Aquatic Metabolism (90^{th} % Whole system t½ in days)	873 (672)	**(MRID 478322-77)**
K_{oc} (Average in L/Kg)	14 (35)	**(MRID 478320-14)** Use Koc for X-540
Chemical Application Method (CAM)	2	
Application Efficiency	95% for aerial 99% for ground	
Spray Drift Fraction	Aerial (0.05) Ground: Airblast (0.01) and others (0.03)	Parameter Guidance[10]

* Half-life values for the residues of interest are calculated from data for parent + X-474 + X-540. Note that half-life values reported earlier in the fate section are as specified either for parent or X-474 or X-540.

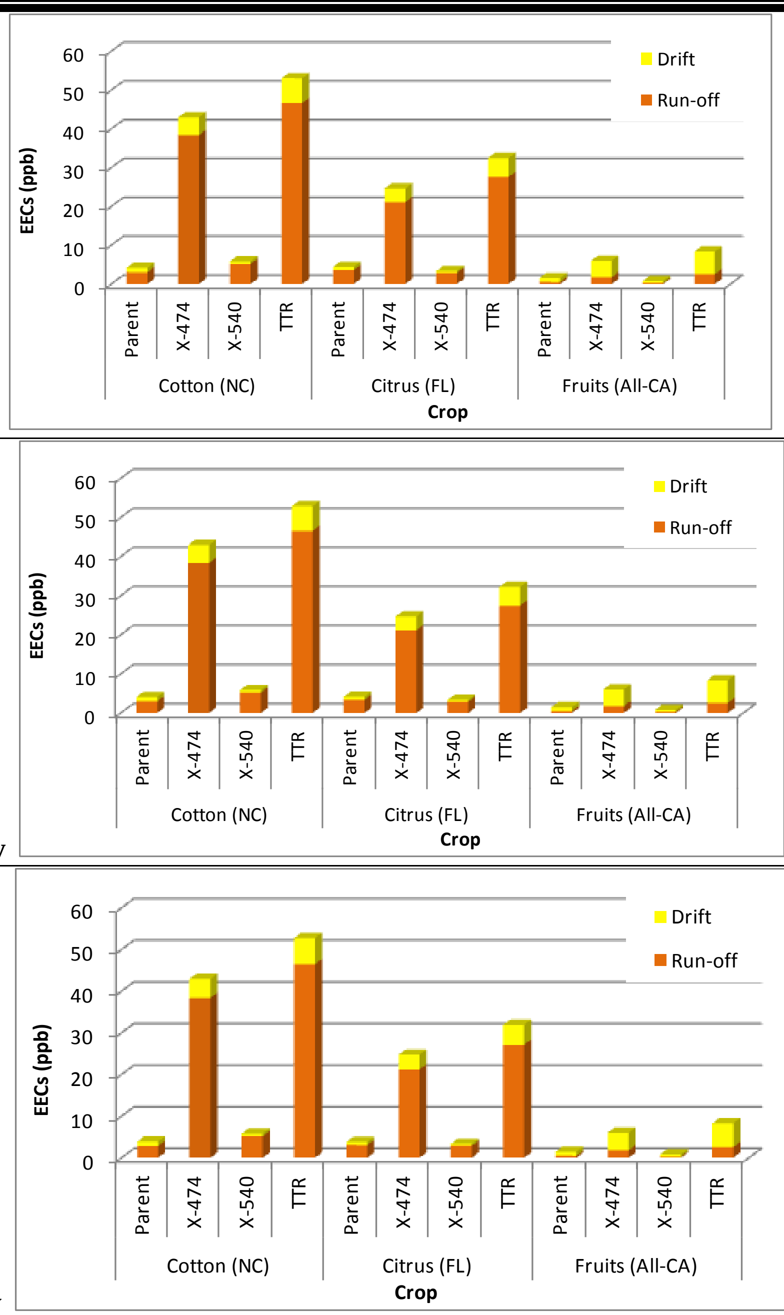
b. Model Residues of Interest for Ground & Aerial Applications Using EXPRESS

Model runs were executed to determine if ground application gives higher EECs than aerial application. As expected, aerial application gave higher EECs compared to ground application, therefore modeling concentrated on aerial application and the results for ground application are not included in this assessment.

The results for these multiple runs gave total, drift and run-off surface water associated EECs for parent (from parent runs), X-474 (estimated to be 88% of "Residues of interest minus parent"), X-540 (estimated to be 12% of "Residues of interest minus parent")[11], and EECs for the total of parent+ X-540+X-474. **Figure 10** shows an example graphical representation for some of these results.

[10] Guidance for Selecting Input Parameters in Modeling the Environmental Fate and Transport of Pesticides. URL: http://www.epa.gov/oppefed1/models/water/input_parameter_guidance.htm

[11] Based on the maximum residues of 12% X-540 found in aerobic soil where it is expected to form.



Peak

21-day

60-day

Figure 10. Surface water peak/21-day/60-day for the residues of interest EECs (µg/L) from cotton and others

RQs were calculated for the EECs of the residues of interest (total of parent+ X-540+X-474) and based on the results only scenarios predicting risk were used to arrive at EECs for the TTR (parent+ X-540). The latter were calculated from parent alone runs as follows:

(1) Parent EECs from parent runs;

(2) X-540 EECs from parent runs (12% of parent due to run-off + 0% of parent due to drift). This is based on the facts that the source of X-540 degradate is expected to be run-off from the soil only (X-540 did not form in laboratory aquatic systems) and that the maximum observed was 12%; and

(3) EECs for the TTR by adding EECs from (1) and (2) above.

EECs for the TTR from the selected scenarios are summarized in **Table 17** for surface water and in **Table 18** for pore water.

Table 17. Surface water EECs (µg/L) of the TTR for Sulfoxaflor use patterns

Crop (State)	*Crop Group(s)*	*Crop(s)*	*Scenario*	*DATE*	*Peak*	*21-day*	*60-day*
Beans (MI)	CG-6	Beans (dry & Lima, snab)	MIbeansSTD	29m07	5.5	5.31	5.05
Citrus (FL)	CG-10	Citrus	FLcitrusSTD	08m04	4.9	4.61	4.16
Cotton (NC)	Cotton	Cotton	NCcottonSTD	23m09	4.6	4.46	4.26
Cotton (MS)	Cotton	Cotton	MScottonSTD	26m08	4.6	4.35	4.02
Vegetables: Brassica (cole) Leafy	CG-5	Broccoli, Brussels sprouts, Cabbage, Cauliflower, Kale	FLcabbageSTD	06m05	1.1	1.01	0.91
Vegetables: Bulb (GA)	CG-3-07	Onion (dry/green) & Pearl	GAOnion_WirrigSTD	26m08	3.1	2.93	2.76
Vegetables: Leafy except Brassica	CG-4	Lettuce/Celery/ Spinach	CAlettuceSTD	22m04	1.7	1.62	1.55
Vegetables: Root & tuber	CG-1& 2	Potatoes, Turnip& Rutabaga	MEpotatoSTD	26m08	2.5	2.48	2.43
Vegetables: Root & tuber	CG-1& 2	Sweet Potatoes	NCsweetpotatoSTD	26m08	4.2	4.01	3.81

Table 18. Pore water EECs (µg/L) of the TTR for Sulfoxaflor use patterns

Crop (State)	*Crop Group(s)*	*Crop(s)*	*Scenario*	*DATE*	*Peak*	*21-day*	*60-day*
Beans (MI)	CG-6	Beans (dry & Lima, snab)	MIbeansSTD	29m07	4.06	4.06	4.04
Citrus (FL)	CG-10	Citrus	FLcitrusSTD	08m04	2.67	2.67	2.63
Cotton (NC)	Cotton	Cotton	NCcottonSTD	23m09	3.37	3.32	3.13
Cotton (MS)	Cotton	Cotton	MScottonSTD	26m08	3.40	3.35	3.26
Vegetables: Brassica (cole) Leafy	CG-5	Broccoli, Brussels sprouts, Cabbage, Cauliflower, Kale	FLcabbageSTD	06m05	0.65	0.65	0.64
Vegetables: Bulb (GA)	CG-3-07	Onion (dry/green) & Pearl	GAOnion_WirrigSTD	26m08	2.02	2.02	1.99

Vegetables: Leafy except Brassica	CG-4	Lettuce/Celery/ Spinach	CAlettuceSTD	22m04	1.33	1.33	1.33
Vegetables: Root & tuber	CG-1& 2	Potatoes, Turnip& Rutabaga	MEpotatoSTD	26m08	2.48	2.47	2.45
Vegetables: Root & tuber	CG-1& 2	Sweet Potatoes	NCsweetpotatoSTD	26m08	3.21	3.21	3.20

a) Estimation of Sediment Concentrations

Exposure EECs to benthic sediment in aquatic systems was obtained for the highest and lowest pore water EECs (**Table 19**).

Table 19. Sediment EECs (µg/kg) for scenarios giving the highest and lowest pore water EECs

Crop (State)	*Crop Group(s)*	*Crop(s)*	*Scenario*	*DATE*	*Peak*	*21-day*	*60-day*
Beans (MI)	CG-6	Beans (dry & Lima, snab)	MIbeansSTD	29m07	7.19	7.18	7.15
Vegetables: Brassica (cole) Leafy	CG-5	Broccoli, Brussels sprouts, Cabbage, Cauliflower, Kale	FLcabbageSTD	06m05	1.15	1.14	1.13

*(2) **Model Runs for Watercress)***

a. Inputs Used for Modeling

Watercress is typically cultivated in shallow, flowing water 2-3 inches deep[12]. The Agency does not currently have a methodology for exposure assessment for crops cultivated in flowing water. In this assessment, conservative EECs resulting from application of sulfoxaflor to watercress were quantitatively obtained using Tier 1 Rice Model. It is noted however, that conservatism in the estimates comes from two assumptions:

(1) The assumption that the pesticide is applied to water although commercial production appear to indicate that the pesticide is to be applied only to the plant foliage with no water present; and
(2) The assumption that surface water EECs is equal to that expected by direct application of the pesticide into a rice paddy. Therefore, modeling results were characterized to reflect effects of application efficiency (fraction of amount applied which is intercepted by the crop), degradation of the pesticide in water after application, and effects of flow through and downstream from the area of cultivation.

Labeled application parameters for watercress calls for a single application of 0.09 lbs a.i/A with a seasonal maximum of three applications totaling 0.266 lbs a.i/acre and a minimum of 7-day

[12] http://www.naturesherbal.com/Watercress.htm and http://edis.ifas.ufl.edu/mv151

reapplication interval. Other input parameters, for the Tier 1 Rice Model include the average K_{oc} (30 L/Kg for parent).

In modeling, parent sulfoxaflor was considered to be the stressor of concern due to the fact that the degradate X-540 is not expected to form in aquatic systems.

b. Results for Modeling

The EECs resulting from the currently proposed three applications is 278 ppb of the TTR which would be parent sulfoxaflor alone because *X-540* is not expected to form in aquatic systems. For a single application, the EEC is 93 ppb TTR while it is 186 ppb TTR following two applications. These initial concentrations estimated by the Tier 1 Rice model assume sulfoxaflor application to watercress growing in a rice paddy containing static water. The only process simulated by the model is partitioning of the applied chemical between the 10-centimeter deep water column and the 1-centimeter deep sediment layer of the paddy. The partitioning is based on the pesticide's partitioning constant (K_d = 0.3 L/Kg calculated by the mode from K_{oc} of 30 L/kg). Other assumptions for the Tier 1 Rice model include:

- All applications are applied at time zero (no application intervals can be simulated);
- The application efficiency is 0.0 (*i.e*., none of the pesticide remains on the watercress plants, which is not a realistic assumption);
- Peak concentrations of the parent occur simultaneously; and
- No degradation occurs in the paddy (the model assumes the residues remain at the initial concentration in the water indefinitely).

Modeling results from Tier 1 Rice model gives concentrations expected in the rice paddy. However, EECs in surface water outside the rice paddy are expected to be affected by many factors. These factors and their impact on modeled EECs are discussed below:

(1) Impact of application efficiency

As stated above, the initial concentrations, in the rice paddy for the TTR of sulfoxaflor are: 93 ppb for single application 186 ppb for two applications, and 278 ppb for three applications. These EECs are based on the assumption that the fraction of amount applied which is intercepted by the crop (*i.e*., the application efficiency) is zero which is not a realistic assumption. **Figure 11** shows the possible impact of application efficiency on the initial concentration in the rice paddy water. Any interception of the applied pesticide (increase in efficiency), by the watercress plant, is expected to reduce EECs on the assumption that the pesticide is reduced by plant intake through leaves before it is washed-off into the soil. In case of sulfoxaflor, the systemic nature of the pesticide increases the chance of this process to occur causing reduction of the EEC values.

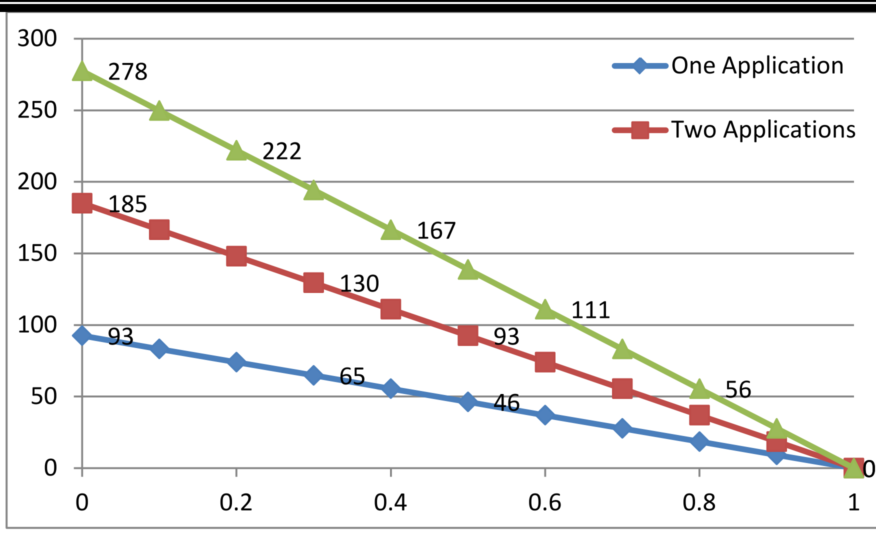


Figure 11. Impact of application efficiency on determined EECS for Surface Water

(2) *Impact of pesticide degradation*

Under field conditions, the initial concentration estimated by the Tier 1 Rice Model (*i.e.*, EECs in the rice paddy) is expected to be reduced by degradation. The impact of degradation on the TTR of sulfoxaflor is only significant only after 100 days and repeated application increased the EECs after 1 year about 10 fold. This is due to observed persistence of parent in water/sediment system (90^{th} % $t_{½}$= 141 days). The effect of degradation on EECs is depicted in **Figure 12.**

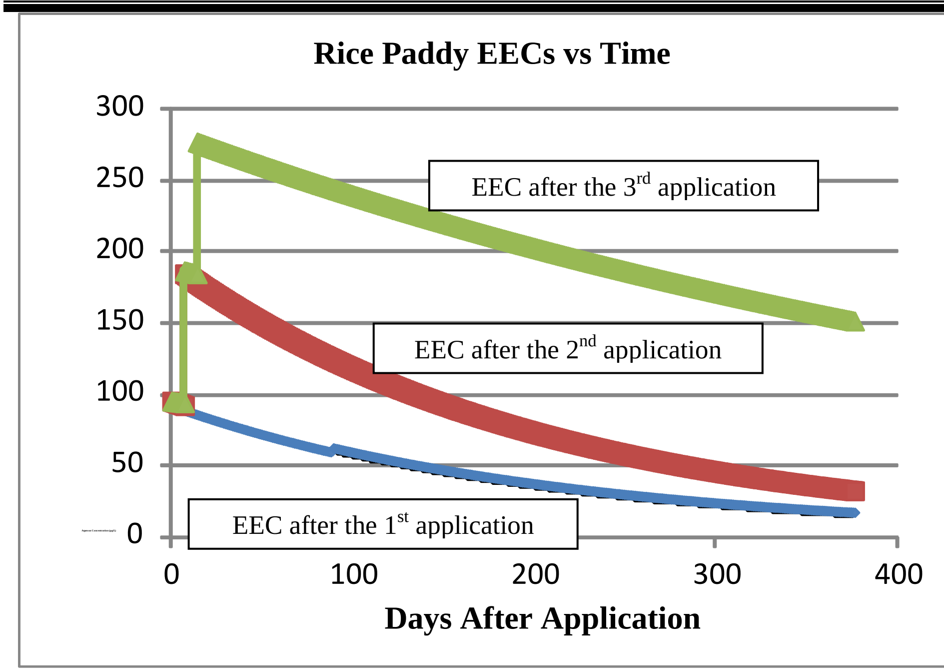


Figure 12. Impact of pesticide degradation on determined EECs in the rice paddy following one (blue line), two (red line) and three (green line) application

In **Figure 12**, the initial EEC value for one application (93 ppb of the TTR) may be reduced by degradation to 15 ppb within a one-year period. The initial EEC value after two applications (184 ppb of the TTR) may be reduced by degradation to 162.6 ppb within a one-year period. Similarly, the initial EEC value following three applications (275 ppb of the TTR) may be reduced by degradation to 149 ppb within a one-year period.

(3) Impact of downstream movement from site in flowing water through watercress cultivated areas

Under actual conditions of watercress cultivation, the amount of pesticide which reaches the stream water will be removed continuously downstream from the site at which it is applied by advection in the flowing water. The rate of removal depends on the rate of flow through the site. River velocity varies from day to day based on the volume of flow and changing cross-sectional area. Typical ranges of velocity vary from zero (at the time of tidal flow direction change) to 7 miles per hour.[13] The Mississippi River ranges from 1.2 to 3 miles per hour depending on the amount of flow and the reach in which it is measured. The pesticide in the flowing water will also spread from the center of mass during the flow. **Figure 13** presents the distance downstream of the center of mass of the applied sulfoxaflor depending on the flow rate of the stream (in miles/hour and in feet/second).

[13] http://hypertextbook.com/facts/2006/NervanaGaballa.shtml

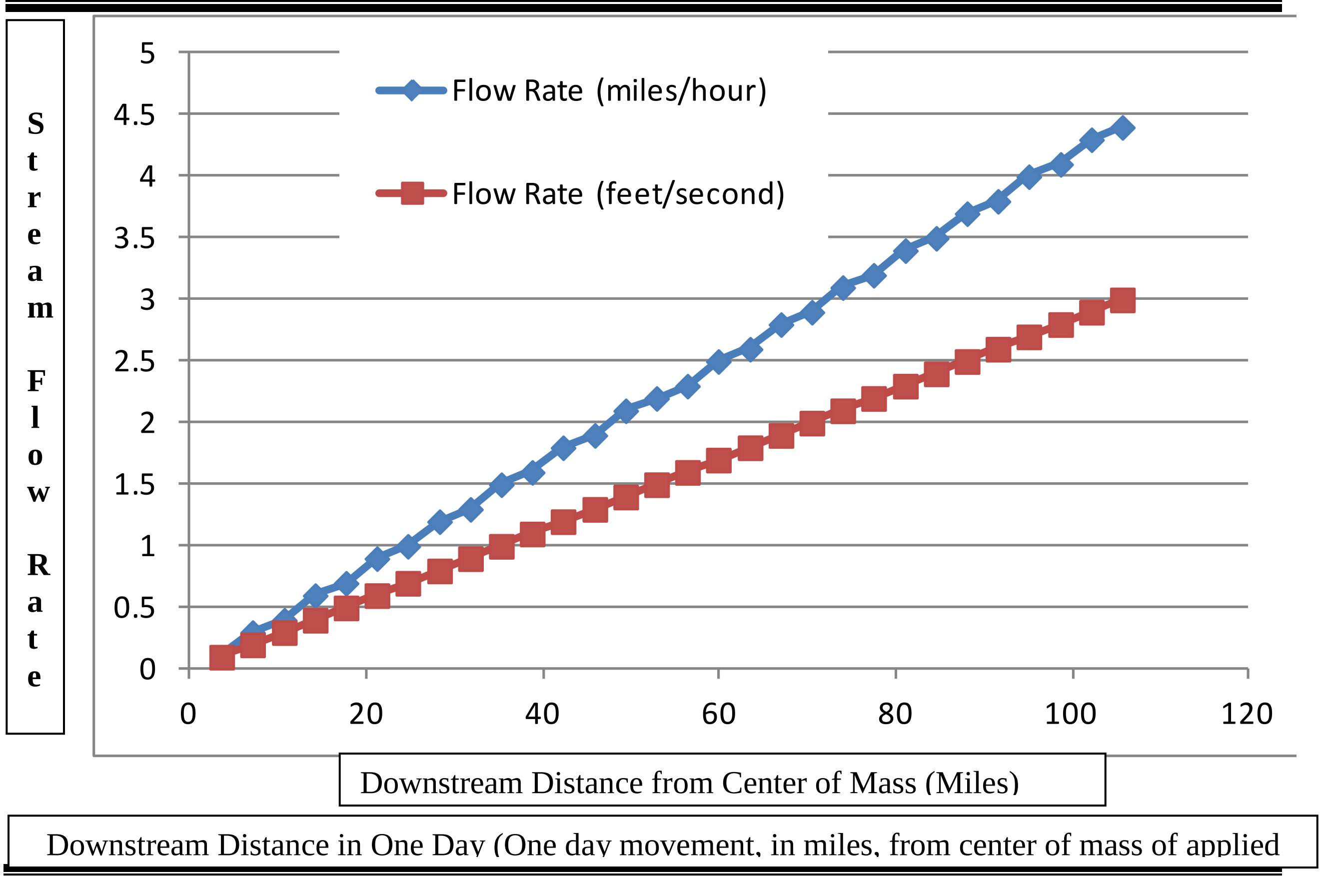


Figure 13. Expected downstream movement, from site of application of sulfoxaflor, in flowing water in one Day

The above presentation suggests that a combination of application efficiency, pesticide degradation and stream flow are expected to produce surface water concentration values lower than the conservative values of 93 to 264 ppb.

(4) Impact of Agronomic Practices

Two important factors can impact EECs arrived at by rice modeling, namely:

(a) Expected usage or acreage that may be treated with the chemical. The EECs from Tier 1 Rice Model are not adjusted for percent crop area (PCA). Lower EECs are expected as a result of such an adjustment due to the fact that reported watercress acreage is limited. In 2007, watercress production totaled nearly 700 acres nationwide, mainly distributed between three states Florida (426 acres), California (151 acres) and Hawaii (15 acres) [14]. Other states where watercress is grown on only few acres include: Alabama, Maryland, Michigan, Pennsylvania, Tennessee and West Virginia. Additionally, the label will further reduce acreage that could potentially be treated with sulfoxaflor as it will limit application of the chemical to "Commercially grown watercress"; and

[14] http://www.agcensus.usda.gov/Publications/2007/Full_Report/usv1.pdf

(b) Known agronomic practices in “commercially grown watercress” are different from those assumed for rice. These practices include[15]:

- Use of flow-through irrigation: water flows through from the top of the crop beds over the surface of beds (having an established gradient) to be collected and pumped back to the top of the beds, *i.e.*, same water is circulated.
- Beds are completely drained prior to, during and after pesticide application
- Depth of flowing water is kept at a maximum depth of one inch.

It is noted that none of these factors were taken in consideration in modeling EECs for sulfoxaflor. However, the most important aspect of the above practices are water reuse (reduce possible contamination for surface waters) and draining of the beds prior to, during and after pesticide application. This limits direct application of the pesticide to water and gives time for its degradation of the parent sulfoxaflor into X-474 reducing the contribution of parent sulfoxaflor to the EECs (i.e., reducing surface water contamination with the stressor “parent sulfoxaflor” as the only expected contaminant would be from parent drift and from X-474 (not considered as part of the stressor in this assessment). In this case, surface water EECs for watercress could be represented by the CA lettuce scenario (**Table 20**).

Table 20. EECs for watercress use when watercress beds are drained prior to, during and after pesticide application sulfoxaflor

Crop (State)	*Crop Group(s)*	*Crop(s)*	*Scenario*	*DATE*	*Peak*	*21-day*	*60-day*
(1) EECs for surface water (ppb)							
Leafy vegetables	CG-4	Lettuce/Celery/ Spinach	CAlettuceSTD	22m04	1.7	1.62	1.55
(2) EECs for pore water (ppb)							
Leafy vegetables	CG-4	Lettuce/Celery/ Spinach	CAlettuceSTD	22m04	1.33	1.33	1.33

b) Aquatic Exposure Monitoring (Field Data)

This is a new pesticide and therefore no data were identified to provide information on aquatic monitoring.

3.2.3 Terrestrial Exposure Assessment

Terrestrial wildlife exposure estimates are typically calculated for bird and mammals, emphasizing a dietary exposure route for uptake of pesticide active ingredients. These exposures

[15] Information is taken from a presentation to EPA by B&W of Florida, a commercial watercress grower.

are considered as surrogates for terrestrial-phase amphibians as well as reptiles. For exposure to terrestrial organisms, such as birds and small mammals, pesticide residues on food items are estimated, based on the assumption that organisms are exposed to a single pesticide residue in a given exposure scenario.

3.2.3.1 . Terrestrial Vertebrate Exposure Modeling

For sulfoxaflor spray applications, estimation of pesticide concentrations in wildlife food items focuses on quantifying possible dietary ingestion of residues on vegetative matter and insects. As described earlier, the EFED terrestrial exposure model T-REX (version 1.5.1) is used to estimate exposures and risks to avian and mammalian species. Input values used for estimating avian and mammalian exposure risks to sulfoxaflor are summarized in **Table 21.**

Table 21. Input parameters used in T-REX v1.5 to determine terrestrial EECs for the maximum sulfoxaflor spray application scenarios.

Input Variable	Parameter Value	Source
Maximum application rate and frequency*	0.133 lb a.i./A x 2 0.090 a.i/A x 3	Product Label
Minimum Application Interval	5-14 days	Product Label
Foliar half-life	12.3 days	Sulfoxaflor residue-decline data (MRID 48755703)

* Crop uses applicable to these use patterns are shown in **Table 4.**

For deriving a sulfoxaflor-specific foliar dissipation rate, an abundance of residue-decline data was available from registrant-submitted field residue trials (MRID 48755703). In selecting data sets for calculating the foliar dissipation half life values, guidelines provided in the T-REX User's Guide was followed.[16] Specifically, residue-decline data sets needed to meet the following criteria in order to be considered for half life calculation:

1. Day 0 measurement of residues available
2. At least 3 measurement times with residues above the limit of detection
3. R^2 values (ln concentration vs. time) of 0.7 or higher
4. Statistical significance of regression coefficient of 0.1 or lower

Based on these criteria, a total of 44 foliar DT_{50} values were available for sulfoxaflor (**Appendix B)**. These DT_{50} values consisted of measurements on a variety of crops and plant matrices (*e.g.*, foliage, fruit, seeds, grains and roots. In situations were multiple trials were available within a crop and crop matrix (*e.g.*, multiple values for head lettuce), the DT_{50} values were averaged. The resulting 25 DT_{50} values averaged within a crop matrix are shown in **Figure 14**. These foliar DT_{50} values ranged from 1.8 to 29, with a calculated 90th percentile DT_{50} of 12.3 days based on log transformed values.

[16] http://www.epa.gov/oppefed1/models/terrestrial/trex/t_rex_user_guide.htm

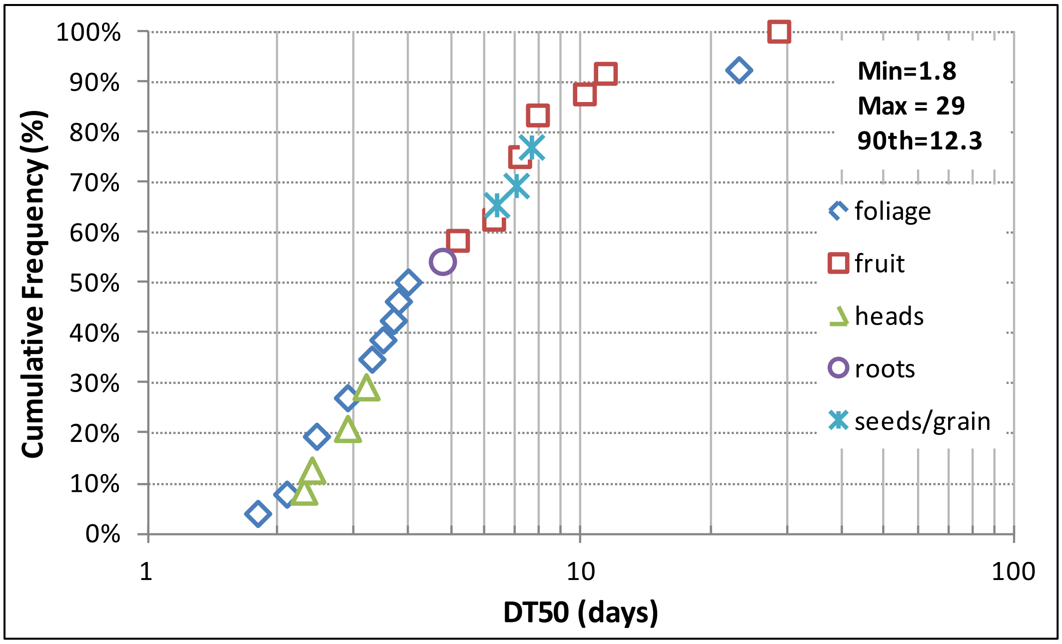


Figure 14. Summary of foliar dissipation half life (DT50) values for sulfoxaflor

It appears from examination **Figure 14** that the crop matrix exerts some influence on the DT_{50} values, with residues measured in fruits and seeds/grains generally having the longest DT_{50} values. With one exception, average crop matrix DT_{50} values measured in plant foliate (leaves, whole plant, straw, hay) are about 4 days or less.

3.2.3.2. Terrestrial Exposure Monitoring (Field Data)

Sulfoxaflor is a new pesticide and therefore, no monitoring data were identified to provide information on chemical concentrations in terrestrial ecosystems. Experimental data documenting residues in plant tissues relevant to exposure of bees to sulfoxaflor are described in **Section 5.1.**

3.2.3.3. Non-Target Plant Exposure Assessment

Tier I seedling emergence and vegetative vigor toxicity tests did not establish EC_{25} estimates, *i.e.*, the EC_{25} values were higher than the highest treatment rate tested, for sulfoxaflor. Specifically, no detrimental effects ≥25% were observed for any test species at rates up to 0.357 lb a.i/A (MRID 47832425 and 47832427) which is approximately 2.5X the maximum single application rate of 0.133 lb a.i/A). Furthermore, NOAEC values for terrestrial plants also exceeded the maximum single application rate of sulfoxaflor tested. Therefore, no exposure modeling was conducted for terrestrial plants since non-listed and listed species LOC of 1.0 could not be exceeded.

4. Ecological Effects Characterization

In screening-level ecological risk assessments, effects characterization describes the types of effects a pesticide can produce in an aquatic or terrestrial organism. This characterization is based on registrant-submitted studies that describe acute and chronic effects toxicity information for various aquatic and terrestrial animals and plants. A summary of the results of the registrant-submitted toxicity studies used to characterize effects for this risk assessment is provided in **Appendix C** (all taxa except bees) and **Appendix D** (for bees). Toxicity testing reported in this section does not represent all species of birds, mammals, or aquatic organisms. Only a few surrogate species for both freshwater fish and birds are used to represent all freshwater fish (2000+) and bird (680+) species in the United States. For mammals, acute studies are usually limited to Norway rat or the house mouse. Estuarine/marine testing is usually limited to a crustacean, a mollusc, and a fish. Also, neither reptiles nor amphibians are tested. The risk assessment assumes that avian serve as a surrogate for the terrestrial-phase amphibians and reptiles. This assessment also assumes that freshwater fish serve as a surrogate for aquatic-phase amphibians.

4.1 Aquatic Effects

A summary of toxicity data for the most sensitive species within each taxonomic group of aquatic organisms is provided in **Table 22**; the most sensitive tested species in each of the taxonomic groups is shown in bold**.** All submitted data for sulfoxaflor were with TGAI; no technical end product (TEP) data were submitted with aquatic organisms.

Table 22. Summary of sulfoxaflor toxicological endpoints for aquatic organisms

Taxa	Species Tested	Toxicity Exposure[1]	Toxicological Endpoint (mg a.i./L)	MRID (Classification)
Freshwater Fish	Rainbow trout (*Oncorhynchus mykiss*)	Acute	LC_{50} (96-hr): >387	47832111 (Acceptable)
	Common carp (*Cyprinus carpio*)	Acute	LC_{50} (96-hr): >402	47832113 (Acceptable)
	Bluegill sunfish (*Lepomis macrochirus*)	Acute	**LC_{50} (96-hr): >363**	4783212 (Supplemental)
	Rainbow trout (*Oncorhynchus mykiss*)	Acute (X11719474)	LC_{50} (96-hr): >478	47832105 (Acceptable)
	Fathead minnow (*Pimephales promelas*)	Chronic	**30-d NOAEC (ELS): 0.66 (reduced dry wt.)**	47832126 (Supplemental)
Freshwater Invertebrate	**Water flea (*Daphnia magna*)**	Acute	**EC_{50} (48-hr): >400**	47832114 (Acceptable)
		Acute (X11719474)	EC_{50} (48-hr): >205	47832106 (Acceptable)
		Chronic	**NOAEC (21-day): 50.5 (reduced reproduction)**	47832127 (Acceptable)
Marine/Estuarine Fish	**Sheepshead minnow (*Cyprinodon variegatus*)**	Acute	**LC_{50} (96-hr): 266**	47832110 (Acceptable)

Taxa	Species Tested	Toxicity Exposure[1]	Toxicological Endpoint (mg a.i./L)	MRID (Classification)
		Chronic	**NOAEC(30-d): 1.2 (reduced length)**	47832129 (Acceptable)
Marine/Estuarine Invertebrate	**Mysid shrimp (*Americamysis bahia*)**	Acute Chronic	**LC_{50} (96-hr): 0.64** **NOAEC: 0.11 (time to first brood)**	47832117 (Acceptable) 47832128 (Acceptable)
	Eastern oyster (*Crassostrea virginica*)	Acute	EC_{50} (96-hr): 86.5	47832115 (Acceptable)
Freshwater Benthic Invertebrates	Midge (*Chironomus dilutus*)	Subchronic	NOAEC (10-d): 0.099 mg a.i/L pore water (dry wt.) NOAEC (10-d): 0.049 mg a.i/kg dry sediment (dry wt.)	47832109 (Acceptable)
	Midge (*Chironomus riparius*)	Chronic	**NOAEC (28-d): 0.037 mg a.i/L pore water (emergence)** **NOAEC (28-d): 0.05 mg a.i/kg dry sediment (emergence)**	Gerke A (2009) (Supplemental)
Aquatic Non-vascular Plants	**Freshwater diatom (*Navicula pelliculosa*)**		**EC_{50} (96-h): 81.2 (Biomass)** **NOAEC (96-h): 3.54 (R,Y,B)** [2]	47832123 (Acceptable)
	Green alga (*Pseudokirchneriella subcapitata*)		EC_{50} (96-h): >101 (R,Y,B) NOAEC (96-h): 101 (R,Y,B)	47832121 (Acceptable)
	Bluegreen alga (*Anabaena flos-aquae*)		EC_{50} (72-h): 83.8 (Y) NOAEC (72-h): 12.0 (G,Y,B)	47832124 (Supplemental)
	Marine diatom (*Skeletonema costatum*)		EC_{50} (96-h): >103 (R,Y,B) NOAEC (96-h): 103 (R,Y,B)	47832122 (Supplemental)
Aquatic Vascular	**Duckweed (*Lemna gibba*)**		**EC_{50} (7-d): >99** **NOAEC (7-d): 99 (dry wt, frond count)**	47832125 (Acceptable)

(1) Test substance is TGAI with purities > 95%.
(2) R= growth rate; Y= yield; B= biomass integral; Toxicity values shown in bold are used for risk estimation
The most sensitive endpoints shown in **bold** were used for risk estimation.

4.1.1 Acute Toxicity to Fish

Sulfoxaflor is classified as practically non-toxic on an acute exposure basis, with 96-h LC_{50} values of >400 mg a.i./L for all three freshwater fish species tested (bluegill, *Lepomis macrochirus*; rainbow trout, *Oncorhynchus mykiss*; and common carp, *Cyprinus carpio*; MRID 47832112, 47832111, and 47832113, respectively). Mortality was 5% or less at the highest test treatments in each of these studies. Treatment-related sublethal effects included discoloration at the highest treatment concentration (100% of fish at 400 mg a.i./L for bluegill) and fish swimming on the bottom (1 fish at 400 mg a.i./L for rainbow trout). No other treatment-related sublethal effects were reported. For an estuarine/marine sheepshead minnow (*Cyprinodon variegatus*; MRID 47832110), sulfoxaflor was also practically non-toxic with an LC_{50} of 288 mg a.i./L. Sublethal effects included loss of equilibrium or lying on the bottom of aquaria at 200 and 400 mg a.i./L. The primary degradate of sulfoxaflor (X474) is also classified as practically non-toxic to rainbow trout on an acute exposure basis (96-h LC_{50} >500 mg a.i./L; MRID 47832105).

4.1.2 Chronic Toxicity to Fish

Adverse effects from chronic exposure to sulfoxaflor were examined with two fish species (fathead minnow, *Pimephales promelas*, MRID 47832126; and sheepshead minnow; MRID 47832129) during early life stage toxicity tests. For fathead minnow, the 30-d NOAEC is 5 mg a.i./L based on a 30% reduction in mean fish weight relative to controls at the next highest concentration (LOAEC=10 mg a.i./L). No statistically significant and/or treatment-related effects were reported for hatching success, fry survival and length. For sheepshead minnow, the 30-d NOAEC is 1.3 mg a.i./L based on a statistically significant reduction in mean length (3% relative to controls) at 2.5 mg a.i./L. No statistically significant and/or treatment-related effects were reported for hatching success, fry survival and mean weight.

4.1.3 Acute Toxicity to Aquatic Invertebrates

The acute (water column) toxicity of sulfoxaflor was evaluated for one freshwater species (waterflea, *Daphnia magna;* MRID 47832114) and two saltwater species (mysid shrimp, *A. bahia;* MRID 47832117 and Eastern oyster, *Crassostrea virginica*; MRID 47832115). For *D. magna*, the 48-h EC_{50} is >400 mg a.i./L, the highest concentration tested . For Eastern oyster, new shell growth was significantly reduced at 120 mg a.i./L (75% reduction relative to control). The 96-h EC_{50} for shell growth is 93 mg a.i./L. No mortality occurred at any test concentration. Mysid shrimp are the most acutely sensitive invertebrate species tested with sulfoxaflor based on water column only exposures, with a 96-h LC_{50} of 0.67 mg a.i./L. The primary degradate of sulfoxaflor (X474) is also classified as practically non-toxic to *D. magna* (EC_{50} >240 mg a.i./L; MRID 47832106).

4.1.4 Chronic Toxicity to Aquatic Invertebrates

The chronic effects of sulfoxaflor to *D. magna* were determined in a semi-static system over a period of 21 days to nominal concentrations of 6.25, 12.5, 25, 50 and 100 mg a.i./L (MRID 47832127). Adult mortality, reproduction rate (number of young), length of the surviving adults, and days to first brood were used to determine the toxicity endpoints. In this flow through study, the test substance was stable and the mean-measured concentrations approximated the nominal concentrations (100-101% of nominal); therefore, the biological endpoints are reported as nominal concentrations. No treatment-related effects on adult mortality or adult length were observed. The reproduction rate and days to first brood were significantly ($p<0.05$) different in the 100 mg a.i./L test group (40% reduction in mean number of offspring; 35% increase in time to first brood). No significant effects were observed on survival, growth or reproduction at the lower test concentrations. The 21-day NOAEC and LOAEC were determined to be 50 and 100 mg a.i./L, respectively.

The chronic effects of sulfoxaflor to mysid shrimp were determined in a flow-through system over a period of 28 days to nominal concentrations of 0.063, 0.13, 0.25, 0.50 and 1.0 mg a.i./L (MRID 47832128). Mortality of parent (F_0) and first generation (F_1), reproduction rate of F_0 (number of young), length of the surviving F_0 and F_1, and days to first brood by F_0 were used to determine the toxicity endpoints. Complete F_0 mortality (100%) was observed at the highest test concentration of 1.0 mg a.i./L within 7 days; no treatment-related effects on F_0/F_1 mortality, F_0 reproduction rate, or F_0/F_1 length were observed at the lower test concentrations, which is somewhat unexpected given the reported acute LC_{50} 0f 0.67 mg a.i./L described previously. The days to first brood by F_0 were significantly ($p<0.05$) different in the 0.25 and 0.50 mg a.i./L test groups (both means: 17.0 days to first brood) relative to the controls (mean: 17.8 days to first brood), although this represents just a 4.5% increase relative to controls. No significant effects on days to first brood by F_0 were observed at the lower test concentrations. The 28-day NOAEC and LOAEC were determined to be 0.11 mg and 0.25 mg a.i./L, respectively.

Although the chemical properties of sulfoxaflor (*i.e.*, low K_{ow}, low partitioning to solids) would not result in a requirement for submitting sediment toxicity testing, the subchronic toxicity of sulfoxaflor to benthic invertebrates via sediment exposure was investigated for larvae of the freshwater chironomid, *Chironomus dilutus* (MRID 47832109). For risk estimation, toxicity endpoints based on concentrations in pore water and sediment are used. Following a 10-day sub-acute exposure to C^{14}-labeled sulfoxaflor administered in spiked sediments, 43% and 0% survival was observed at mean sediment concentrations of 0.17 and 0.36 mg a.i./kg dry sediment, respectively. Analysis of overlying water samples taken from the 1.0 mg a.i./L treatment via HPLC/MS/MS indicate that nearly all of the TRR was parent compound over the 10-day study duration (only 3% was detected as X-474 by day 10). Survival in all other treatments (0.025 to 0.09 mg a.i./kg dry sediment and controls) was 93% or greater. The NOAEC based on dry weight is 0.049 mg TRR/kg dry sediment with a 31% reduction in mean dry weight occurring in the next highest treatment (0.09 mg TRR/kg dry sediment). This NOAEC is equivalent to 0.099 mg a.i./L (mean-measured) in pore water.

The chronic toxicity of sulfoxaflor to midge larvae (*C. riparius*) in whole sediment was determined using spiked water dosing. Midges were exposed to sulfoxaflor applied to the overlying water in a static system over a period of 28 days to nominal concentrations of 0.065, 0.13, 0.25, 0.50 and 1.0 mg a.i./L. Emergence, development rate and survival were used to determine the toxicity endpoints. The TRR in the overlying water decreased to about 72-81% of nominal after 28 days which was attributed to the test substance being incorporated into the pore water and sediment based on analytical results from the study. Approximately two-thirds of the residues in the overlying water of the 0.100 mg a.i./L treatment were determined to be sulfoxaflor, while X474 comprised the remaining third; therefore, the biological endpoints are reported as mean-measured TRR concentrations (0.00142, 0.00286, 0.00604, 0.0112, 0.0225, 0.0455 and 0.0949 mg TRR/L overlying water). Emergence was significantly lower at 0.0949 mg TRR/L (mean: 70%) relative to controls (mean: 91%). No treatment-related effects on development rate were observed. The 28-day NOAEC was determined to be 0.046 mg TRR/L for overlying water, 0.037 mg TRR/L for pore water, and 0.05 mg/kg for dry sediment. Since effects on midge reproduction were not quantified per USEPA Agency-wide guidelines for chronic sediment toxicity testing (USEPA, 2000), this test is classified as supplemental.

4.1.5 Toxicity to Aquatic Plants

Sulfoxaflor exhibited relatively low toxicity to aquatic non-vascular plants. The most sensitive aquatic nonvascular plant is the freshwater diatom, *Navicula pelliculosa*, with a 96-h EC_{50} of 81.2 mg a.i./L (MRID 47832123) Similarly, sulfoxaflor was not toxic to the freshwater vascular aquatic plant, *Lemna gibba*, up to the limit amount, as indicated by a 7-d EC_{50} for frond count, dry weight and growth rate of >100 mg a.i./L (MRID 47832125) with no significant adverse effects on these endpoints observed at any treatment concentration.

4.2 Terrestrial Effects

A summary of toxicological endpoints for terrestrial organisms exposed to sulfoxaflor is provided in **Table 23**.

Table 23. Summary of sulfoxaflor toxicological endpoints for terrestrial organisms.

Taxa	Species	Type of Toxicity (Purity)[1]	Toxicological Endpoint	MRID
Birds	Bobwhite Quail *(Colinus virginianus)*	Acute (oral) (95.6%; TGAI)	LD_{50}: 676 mg/kg bw	47832101 (Acceptable)
	Zebra finch (*Poephila guttata*)		**LD_{50}: >80 mg/kg bw**	47832072 (Supplemental)
	Bobwhite Quail *(Colinus virginianus)*	Acute (oral) X11719474 (99.5%)	LD_{50}: > 2,250 mg/kg bw	47832073 (Acceptable)
	Bobwhite Quail *(Colinus virginianus)*	Subacute (dietary) (95.6%; TGAI)	LC_{50}(5-d): > 5,620 ppm	47832074 (Acceptable)
	Mallard duck *(Anas platyrhynchus)*		**LC_{50}(5-d): >5,620 ppm**	47832104 (Acceptable)
	Bobwhite Quail *(Colinus virginianus)*	Chronic (95.6%; TGAI)	NOAEL (20 wk): 1,000 ppm (81 mg ai/kg bw/d)	47832119 (Acceptable)
	Mallard duck *(Anas platyrhynchus)*		**NOAEL (20 wk): 200 ppm (26 mg ai/kg bw/d)**	47832120 (Acceptable)
Mammals	Rat (*Rattus norvegicus*)	Acute (oral) (95.6%; TGAI)	LD_{50} 1000 mg ai/kg bw (female)	47832144 (Acceptable)
	Mouse (*Mus musculus*)		LD_{50} 750 mg ai/kg bw	47832040 (Acceptable)

Taxa	Species	Type of Toxicity (Purity)[1]	Toxicological Endpoint	MRID
	Rat (*Rattus norvegicus*) Rat (*Rattus norvegicus*)	Acute (oral) GF-2372 TEP (40%)	LD_{50} >2000 mg ai/kg bw	47832505 (Acceptable)
		Acute (oral) GF-2032 TEP (22%)	LD_{50} >5000 mg ai/kg bw	47832407 (Acceptable)
		Chronic dietary (95.6%; TGAI)	**NOAEL (two generation): 100 ppm (6.07 mg ai/kg bw) (decreased neonatal survival)**	47832142 (Acceptable)
Terrestrial Invertebrates	**Honey bee, adult (*Apis mellifera*)**	Acute (contact) TGAI	LD_{50} (72-h): 0.379 ug a.i./bee	47832102 (Acceptable)
		Acute (contact) TEP: GF-2032-SC	**LD_{50} (48-h): 0.130 ug a.i./bee**	47832419 (Acceptable)
		Acute (contact) TEP: GF-2372-WG	LD_{50} (48-h): 0.224 ug a.i./bee	47832511 (Acceptable)
		Acute (oral) TGAI	LD_{50} (48-h): 0.146 ug a.i./bee	47832103 (Acceptable)
		Acute (oral) TEP: GF-2032-SC	**LD_{50} (48-h): 0.052 ug a.i./bee**	47832417 (Acceptable)
		Acute (oral) X11719474	LD_{50} (96-h): >100 ug a.i./bee	47832107 (Acceptable)
		Acute (oral) X11721061	LD_{50} (48-h): >104 ug a.i./bee	48445809
		Acute foliar residue (TEP: GF-2372-WG)	24-h aged residue mortality: 14% (0.089 lb ai/A or 100 g ai/ha) 15% (0.178 lb ai/A or 200 g ai/ha)	47832512 (Acceptable)
		Acute foliar residue (TEP: GF-2032-SC)	3-h aged residue mortality: 4% (200 g ai/ha)	47832420 (Acceptable)
	Honey bee, larvae (*Apis mellifera*)	Chronic, single dose (TGAI)	NOAEC (7-d): 0.2 µg a.i./bee larvae	48755602 (Supplemental)
		Chronic, repeated dose (TGAI)	**NOAEC (7-d): 0.02 µg a.i./bee larvae**	48755603 (Supplemental)
	Bumble bee, adult (*Bombus terrestris*)	Acute (contact) (TEP: GF-2032-SC)	LD_{50} (72-h): 7.55 µg a.i./bee	47832418 (Supplemental)
		Acute (oral) (TEP: GF-2032-SC)	LD_{50} (72-h): 0.027 µg a.i./bee	47832418 (Supplemental)
Terrestrial plants	Multiple species	Tier 1 – Seedling Emergence (TEP: GF-2032-SC)	EC_{25} (21-d): > 0.357 lb ai/A (>400 g ai/ha) NOAEC = 0.357 lb ai/A (400 g ai/ha)	47832427 (Acceptable)

Taxa	Species	Type of Toxicity (Purity)[1]	Toxicological Endpoint	MRID
Terrestrial plants	Multiple species	Tier 1/2 – Vegetative Vigor (TEP: GF-2032-SC)	EC_{25} (21-d): > 0.178 lb ai/A (>200 g ai/ha) NOAEC = 0.178 lb ai/A (200 g ai/ha)	47832425 (Supplemental)

The most sensitive endpoints shown in bold were used for risk estimation.

4.2.1 Toxicity to Birds

Based on an acute oral LD_{50} of 676 mg a.i./kg bw for bobwhite quail (*Colinus virginianus*), sulfoxaflor is considered slightly toxic to birds on an acute oral exposure basis (MRID 47832101). The acute oral LD_{50} could not be determined for the passerine zebra finch (*Taeniopygia guttata*; MRID 47832072) due to regurgitation at treatments above 29 mg a.i./kg bw). In this study, 40% mortality was observed at the highest dose (200 mg a.i./kg bw) with no mortality occurring at lower doses. In the controls and lowest dose (29 mg a.i./kg bw), no birds regurgitated. A dose-dependent increase in the rate of regurgitation was observed at higher treatments (1/10 at 49 mg a.i./kg bw; 2/10 at 80 mg a.i./kg bw; 7/10 at 132 mg a.i./kg bw; 10/10 at 200 mg a.i./kg bw). Sublethal effects at 49 mg a.i./kg bw and above included ruffled appearance, loss of coordination, lower limb weakness, prostrate posture, loss of righting reflex, convulsions and lethargy). The LD_{50} to estimated to be >80 mg a.i./kg bw based on the lowest level at which ≤20% birds regurgitated and no mortality occurred. Thus, even one assumes all the birds that regurgitated their dose would have died, the LD_{50} would be somewhere between 80 and 132 mg a.i./kg bw (20% and 70% regurgitation).

On a subacute, dietary exposure basis, sulfoxaflor is classified as practically nontoxic to birds, with 5-d LC_{50} values of >5620 mg/kg-diet for mallard ducks (*Anas platyrhynchus*) and bobwhite quail (MRID 47832104 and 47832074, respectively). The NOAEL from these studies is 5620 mg/kg-diet as no treatment related mortality of sublethal effects were observed at any treatment. Similarly, the primary degradate (-474) is classified as practically nontoxic to birds on an acute oral exposure basis with a LD_{50} of >2250 mg a.i./kg bw (MRID 47832073).

In two chronic, avian reproductive toxicity studies, the 20-week NOAELs ranged from 200 mg/kg-diet (mallard, MRID 47832120, highest concentration tested) to 1000 mg/kg-diet (bobwhite quail, highest concentration tested). No treatment-related adverse effects were observed at any test treatment in these studies.

4.2.2 Toxicity to Mammals

In an acute oral ‘up-down’ toxicity study conducted according to Organization for Economic Cooperation and Development (OECD) protocol (MRID 47832144), a series of fasted, young adult rats (6/sex) were given a single oral dose of sulfoxaflor XDE-208 in 0.5% aqueous methylcellulose at either 630 mg/kg bw (2 males, 2 females), 1000 mg/kg bw (2 males, 3 females), 1580 mg/kg bw (1 male, 1 female) or 2000 mg/kg bw (1 male). Based on an estimated LD_{50} of 1000 mg/kg bw, and an assumed standard deviation of 0.2, a starting dose level of 630 mg/kg bw of sulfoxaflor was administered to one male and one female rat. Since both animals survived, the second animals received a higher dose at 1000 mg/kg bw. Clinical signs included muscle tremors, twitches, tonoclonic convulsions, decreased activity, decreased reactivity, decrease fecal output, eyelids partially closed (ptosis), hair standing up (piloerection), labored respiration, soiling, increased salivation, increased lacrimation, lack of coordination, hypersensitivity to stimuli, , and decreased responsiveness to touch. Mortality was observed at ≥1000 mg/kg bw. The male and female acute LD_{50} values were estimated to be 1405 and 1000 mg/kg bw, respectively.

In an acute oral up-down toxicity study conducted according to OECD guidelines (MRID 47832040), a series of fasted, young adult male mice were given a single oral dose of sulfoxaflor 95.6% TGAI n 0.5% aqueous methylcellulose at either 560 mg/kg bw (1 animal), 750 mg/kg bw (3 animals) or 1000 mg/kg bw (1 animal). Clinical signs noted prior to death included muscle twitches, tremors, and convulsions, increased reactivity to stimuli, and increased responsiveness to touch. No gross internal findings were observed at necropsy. The oral LD_{50} was determined to be 750 mg a.i./kg bw.

The acute, oral toxicity of formulated products GF-2372 and GF-2032 was also evaluated with the rat at limit doses of 2000 and 5000 mg a.i./kg bw (MRID 47832505 and 47832407, respectively). In both studies, no mortality or deleterious effects on body weight occurred at the limit doses. Rats exposed to GF-2372 showed sublethal effects including facial staining, ano-genital staining and/or reduced fecal volume; all animals recovered with normal behavior at 8 days. No sublethal signs of toxicity were observed with rats administered 5000 mg a.i./kg bw GF-2032.

In a chronic two-generation dietary reproduction toxicity study, sulfoxaflor (95.6% purity) was administered to Sprague Dawley rats (27/sex/dose group) at concentrations of 0, 25, 100 or 400 ppm in the diet for approximately ten weeks prior to breeding, and continuing through breeding, gestation and lactation for two generations. In-life parameters included clinical observations, feed consumption, body weights, estrous cyclicity, reproductive performance, pup survival, pup body weights, puberty onset and anogenital distance. In addition, post-mortem evaluations included gross pathology and organ weights in weanlings, toxicokinetic analyses, gross pathology, organ weights, oocyte quantitation and sperm count, motility and morphology, and histopathology, in adults. Systemic effects in parents consisted of only increased absolute and relative liver weights; these effects are not considered to be ecologically relevant and are not considered for the wild mammal risk assessment. Reproductive effects were limited to 400 ppm and comprised slightly decreased neonatal survival in both generations (81.2 vs. 95.4% in controls); this in turn led to a lower percentage of live pups up to culling on post-natal day 4 (PND 4). In addition, there was an apparent treatment-related delay in preputial separation (PPS) for 400 ppm F_1 males. This external marker of male puberty onset is androgen dependent, but the underlying reason for how sulfoxaflor induced this finding is not known. There were no effects on the onset of puberty or any other parameter of reproductive performance or offspring growth and survival at 25 or 100 ppm. Toxicokinetic data from lactation day 4 (LD 4) dams and culled PND 4 pups in the second generation show dose-proportional systemic exposure to sulfoxaflor in dams and their offspring. The LOAEL for reduced neonatal survival is 400 ppm (24.6 mg/kg/day) and the NOAEL is 100 ppm (6.07 mg/kg/day).

4.2.3 Toxicity to Bees

Sulfoxaflor is considered highly toxic to the honeybee, *Apis mellifera*, with an acute contact LD_{50} value of 0.379 µg ai/bee (TGAI; MRID 47832102) and 0.130 µg ai/bee (formulated product GF-2032-SC; MRID 47832419). Sulfoxaflor was also highly toxic on an acute oral basis (LD_{50} value of 0.146 µg ai/bee (TGAI, MRID 47832103) and 0.052 µg ai/bee (formulated product GF-2032-SC, MRID 47832417). Conversely, the primary degradate (X474) is classified as practically nontoxic to bees on an acute contact basis with an acute contact LD_{50} of >100 ug/bee (MRID 47832107). Based on aged residues of GF-2032-SC on alfalfa at 200 g/ha, <5% mortality occurred following exposure to alfalfa aged from 3 to 24 hours (MRID 47832420). With the GF-2372-WG formulation, up to 15% mortality occurred following exposure to alfalfa aged from 3-24 hours (MRID 47832512).

For the bumble bee, *Bombus terrestris*, sulfoxaflor (formulated product, GF-2032-SC) was much less toxic compared to honeybee on an acute contact basis (LD_{50} of 7.55 µg ai/bee, MRID 47832418) compared to 0.130 µg ai/bee for the honeybee). However, based on acute <u>oral</u> exposure, the toxicity of sulfoxaflor formulated product (GF-2032-SC) was similar among the bumble bee and honeybee (72-h LD_{50} of 0.027 µg ai/bee; MRID 47832511 and 48-h LD_{50} of 0.052 µg ai/bee, respectively).

4.2.4 Toxicity to Terrestrial Plants

Sulfoxaflor did not exhibit treatment-related signs of toxicity to terrestrial plants at or above the proposed maximum seasonal application rate on cotton (200 g/ha) based on vegetative vigor and seedling emergence tests (MRID 47832425 and 47832427, respectively).

5. Risk Characterization

Risk characterization provides the final step in the risk assessment process. In this step, exposure and effects characterization are integrated to provide an estimate of risk relative to established levels of concern (LOCs; **Section 5.1**). The results are then interpreted for the risk manager through a risk description and synthesized into an overall conclusion (**Section 5.2**). In addition, the risk description also contains a discussion of relevant sources of uncertainty in the risk assessment and sensitivity of the risk assessment findings to important methodological assumptions.

5.1 Risk Estimation - Integration of Exposure and Effects Data

As discussed in the problem formulation, risk characterization integrates EECs and toxicity estimates and evaluates the likelihood of adverse ecological effects to non-target species. For sulfoxaflor, a deterministic approach is used to evaluate the likelihood of adverse ecological effects to non-target species. In this approach, RQs are calculated by dividing EECs by acute and chronic ecotoxicity values for non-target species.

Risk Quotient (RQ) = Exposure Estimate/Toxicity Estimate

RQs are then compared to LOCs. These LOCs are criteria used to indicate potential risk to non-target organisms and the need to consider regulatory action. LOC exceedence is interpreted to mean that the labeled use (or proposed use) of the pesticide has the potential to cause adverse effects on non-target organisms. LOCs currently address the following risk presumption categories:

Animals:

- **acute risk** - potential for acute risk to non-target organisms which may warrant regulatory action in addition to restricted use classification,
- **acute risk, restricted use** – potential for acute risk to non-target organisms, but may be mitigated through restricted use classification,
- **acute risk, listed species** – listed species may be potentially affected by use,
- **chronic risk** – potential for chronic risk may warrant regulatory action, listed species may potentially be affected through chronic exposure,

Plants

- **non-listed plant risk** - potential for effects in non-target (non-endangered) plants, and
- **listed plant risk** – potential for effects in endangered plants.

Risk presumptions, along with the calculation of the corresponding RQs and LOCs, are tabulated below:

Table 24. Risk Presumptions for Aquatic Animals

Risk Presumption	RQ	LOC
Acute Risk	EEC/LC_{50} or EC_{50}	0.5
Acute Restricted Use	EEC/LC_{50} or EC_{50}	0.1
Acute Endangered Species	EEC/LC_{50} or EC_{50}	0.05
Chronic Risk	EEC/NOAEC	1

Table 25. Risk Presumptions for Terrestrial Vertebrate Animals

Risk Presumption	RQ	LOC
Acute Risk	Diet-based EEC/LC_{50} or Dose-based EEC/LD_{50}	0.5
Acute Restricted Use	Diet-based EEC/LC_{50} or Dose-based EEC/LD_{50} (or LD_{50} < 50 mg/kg)	0.2
Acute Endangered Species	Diet-based EEC/LC_{50} or Dose-based EEC/LD_{50}	0.1
Chronic Risk	Diet or Dose-based EEC/Diet or Dose-based NOAEC	1

Table 26. Risk Presumptions for Terrestrial Invertebrate Animals

Risk Presumption	RQ	LOC
Acute Risk to Bees(1)	EEC (adult contact) / LD_{50} (adult contact)	
	EEC (adult or larvae oral) / LD_{50} (adult or larvae oral)	0.4
Chronic Risk to Bees (1)	EEC (adult or larvae oral) / NOAEC or LD10 (adult or larvae)	1

(1) RQ and LOC values for bees are proposed values (USEPA 2012).

Table 27. Risk Presumptions for Plants

Risk Presumption	RQ	LOC
Terrestrial Plants in Terrestrial and Semi-Aquatic Areas:		
Non-Endangered Species	EEC(1)/EC_{25}	1
Endangered Species	EEC/EC_{05} or NOAEC	1
Aquatic Plants:		
Non-Endangered Species	EEC(2)/EC_{50}	1
Endangered Species	EEC/EC_{05} or NOAEC	1

5.1.1. Risks to Non-Target Aquatic Animals

Acute and chronic risks to aquatic animals are first estimated based on the maximum aquatic EECs determined from all 51 crop exposure scenarios modeled combined with the most sensitive endpoint within each taxonomic group, as identified in **Table 22**. For screening purposes, this initial comparison is based on the total residues of interest (parent +X-474+X-540). If the maximum RQ value did not exceed the applicable LOC, then no further risk estimation was conducted and a low potential for risk was presumed. If maximum RQ value exceeded the acute or chronic risk LOC, then RQ values re-calculated using the refined EECs with parent and X-540 constituents, which are considered the residues of toxicological concern.

5.1.1.1. Fish and Invertebrates: Water Column Exposure

Sulfoxaflor is classified as practically non-toxic to freshwater and saltwater fish on an acute exposure basis. As a result, maximum acute and chronic RQ values for freshwater and saltwater fish determined with the crop exposure scenario producing the highest aquatic EECs (NC Cotton) are one to three orders of magnitude below the listed and non-listed species LOC values of 0.5 and 0.05, respectively (**Table 28**).

Table 28. Maximum acute and chronic risk quotients for freshwater and saltwater fish based on total residues of interest

Use Category	Crop Scenario	Peak EEC[1] (mg/L)	60-day EEC[1] (mg/L)	Acute RQ [2]		Chronic RQ [3]	
				FW	SW	FW	SW
Cotton	NC Cotton	0.0530	0.0527	<0.0001	0.0002	0.08	0.04

[1] For screening purposes, these EECs are based on total residues of interest (parent + X-474 + X-540).
[2] Acute RQ values for freshwater and saltwater fish are based on the peak EEC / LC_{50} values of >363 mg a.i./L (bluegill sunfish) and 266 mg a.i./L (sheepshead minnow), respectively (see **Table 22**)
[3] Chronic RQ values for freshwater and saltwater fish are based on the 60-d average EEC / NOAEC values of 0.66 mg a.i./L (fathead minnow) and 1.2 mg a.i./L (sheepshead minnow), respectively (see **Table 22**)

Maximum acute RQ values for freshwater invertebrates are three orders of magnitude below the acute risk to listed species LOC while that for saltwater invertebrates marginally exceeds (RQ=0.08) the acute risk to listed species LOC of 0.05 (**Table 29**). Maximum chronic RQ values do not exceed the chronic risk LOC (1.0) for either freshwater or saltwater invertebrates.

Table 29. Maximum acute and chronic risk quotients for freshwater and saltwater Invertebrates based on total residues of interest

Use Category	Crop Scenario	Peak EEC (mg/L)	21-day EEC (mg/L)	Acute RQ [2]		Chronic RQ [3]	
				FW	SW	FW	SW
Cotton	NC Cotton	0.053	0.0529	<0.0001	**0.08**[4]	0.001	0.5

[1] For screening purposes, these EECs are based on total residues of interest (parent + X-474 + X-540).
[2] Acute RQ values for freshwater and saltwater invertebrates are based on the peak EEC / LC_{50} values of >400 mg a.i./L (*Daphnia magna*) and 0.64 mg a.i./L (mysid shrimp), respectively (see **Table 22**)
[3] Chronic RQ values for freshwater and saltwater invertebrates are based on the 21-d average EEC / NOAEC values of 50.5 mg a.i./L (*D. magna*) and 0.11 mg a.i./L (mysid shrimp), respectively (see **Table 22.**)
[4] **Bolded** value exceeds acute risk to listed species LOC of 0.05.

Since the maximum acute RQ for saltwater invertebrates exceeds the acute risk to listed species LOC based on total residues of interest, acute RQ values were re-calculated with refined EECs that include only the toxicological residues of concern (parent + X-540) for those exposure scenarios with RQs that exceed the LOC. These refined RQ values are shown in **Table 30** and are well below LOCs for non-listed and listed species.

Table 30. Acute risk quotients for saltwater invertebrates using refined EECs based on total toxic residues of concern

Crop (State)	Crop(s)	Scenario	EEC Total (ug ai/L)[1]	Acute RQ [2,]
Beans (MI)	Beans (dry & Lima, snab)	MIbeansSTD	5.5	0.009
Citrus (FL)	Citrus	FLcitrusSTD	4.9	0.008
Cotton (NC)	Cotton	NCcottonSTD	4.6	0.007
Cotton (MS)	Cotton	MScottonSTD	4.6	0.007
Vegetables: Brassica (cole) Leafy	Broccoli, Brussels sprouts, Cabbage, Cauliflower, Kale	FLcabbageSTD	1.1	0.002
Vegetables: Bulb (GA)	Onion (dry/green) & Pearl	GAOnion_WirrigSTD	3.1	0.005
Vegetables: Leafy except Brassica	Lettuce/Celery/ Spinach	CAlettuceSTD	1.7	0.003
Vegetables: Root & tuber	Potatoes, Turnip& Rutabaga	MEpotatoSTD	2.5	0.004
Vegetables: Root & tuber	Sweet Potatoes	NCsweetpotatoSTD	4.2	0.007

[1] EECs are based on total toxic residues of concern (parent + X-540; see **Table 17**).
[2]Acute RQ values for saltwater invertebrates are based on the peak EEC / LC_{50} values of 0.64 mg a.i./L (mysid shrimp; see **Table 22**).

5.1.1.2. Aquatic Invertebrates: Sediment Exposure

Risk quotients for freshwater and saltwater benthic invertebrates using the crop exposure scenario with the highest acute and chronic EEC in sediment porewater (NC cotton) are provided in **Table 31**. For estimating acute risks to benthic invertebrates, risk quotients were determined using peak porewater EECs (reported in **Table 18**) divided by the lowest acute toxicity endpoint for fresh and saltwater water column invertebrates, since acute toxicity data were not available from sediment toxicity studies. For estimating chronic risks to benthic invertebrates, risk quotients were determined by dividing the highest 21-d average EEC in pore water by the lowest pore water NOAEC obtained for the midge (freshwater) and water column exposure NOAEC for mysid shrimp. As the pore water EECs were nearly identical to the water column EECs, RQ values based on water column toxicity data (acute FW & SW, chronic SW) are identical to those described earlier in **Table 29**. For fresh water benthic invertebrates, a slight exceedance (RQ=0.08) of the acute risk to listed species LOC and the chronic risk (RQ=1.4) LOC is indicated.

Table 31. Maximum acute and chronic risk quotients for freshwater and saltwater benthic invertebrates based on total residues of interest

Use Category	Crop Scenario	Peak Pore Water EEC [1] (mg/L)	21-day Pore Water EEC[1] (mg/L)	Acute RQ [2, 3]		Chronic RQ [3, 4]	
				FW	SW	FW	SW
Cotton	NC Cotton	0.051	0.050	<0.0001	**0.08**	**1.4**	0.5

[1] For screening purposes, these EECs are based on total residues of interest (parent + X-474 + X-540).
[2] Acute RQ values for benthic freshwater and saltwater invertebrates are based on the peak pore water EEC / EC_{50} values of >400 mg ai/L (*Daphnia magna*) and an LC_{50} value of 0.64 mg ai/L (mysid shrimp), respectively (see **Table 22**)
[3] Chronic RQ values for freshwater and saltwater benthic invertebrates are based on the 21-d average pore water EEC / 28-d NOAEC values of 0.037 mg ai/L-pore water (*Chironomus riparius)* and 0.11 mg ai/L (mysid shrimp), respectively (see **Table 22**)
[3] **Bolded** value exceeds acute risk to listed species LOC of 0.05
[4] **Bolded** value exceeds chronic risk to listed species LOC of 1.0

Since the maximum acute RQ for saltwater benthic invertebrates using the total residues of interest exceeds the acute risk to listed species LOC and the maximum chronic RQ for freshwater benthic invertebrates the chronic risk LOC, acute and chronic RQ values were for those scenarios exceeding the LOCs were re-calculated using just the residues of toxicological concern (parent and X-540). Those RQ values that exceeded the acute risk to listed species LOCs and chronic risk LOCs are provided in **Table 32.** These refined RQ values are well below acute and chronic risk LOCs for non-listed and listed species.

Table 32. Risk quotients for benthic Invertebrates using refined EECs based on total toxic residues of concern

Crop (State)	Crop(s)	Scenario	Peak Pore Water EEC (mg ai/L)	SW Acute RQ [1]	21-d Avg. Pore Water EEC (mg ai/L)	FW Chronic RQ [2]
Beans (MI)	Beans (dry & Lima, snab)	MIbeansSTD	4.06	0.006	4.06	0.11
Citrus (FL)	Citrus	FLcitrusSTD	2.67	0.004	2.67	0.07
Cotton (NC)	Cotton	NCcottonSTD	3.37	0.005	3.32	0.09
Cotton (MS)	Cotton	MScottonSTD	3.40	0.005	3.35	0.09
Vegetables: Brassica (cole) Leafy	Broccoli, Brussels sprouts, Cabbage, Cauliflower, Kale	FLcabbageSTD	0.65	0.001	0.65	0.02
Vegetables: Bulb (GA)	Onion (dry/green) & Pearl	GAOnion_WirrigSTD	2.02	0.003	2.02	0.05
Vegetables: Leafy except Brassica	Lettuce/Celery/ Spinach	CAlettuceSTD	1.33	0.002	1.33	0.04
Vegetables: Root & tuber	Potatoes, Turnip& Rutabaga	MEpotatoSTD	2.48	0.004	2.47	0.07
Vegetables: Root & tuber	Sweet Potatoes	NCsweetpotatoSTD	3.21	0.005	3.21	0.09

Crop (State)	Crop(s)	Scenario	Peak Pore Water EEC (mg ai/L)	SW Acute RQ [1]	21-d Avg. Pore Water EEC (mg ai/L)	FW Chronic RQ [2]
[1] Acute RQ values for benthic saltwater invertebrates are based on the peak pore water EEC / LC_{50} value 0.64 mg ai/L (mysid shrimp; see **Table 22**) [2] Chronic RQ values for freshwater benthic invertebrates are based on the 21-d average pore water EEC / 28-d NOAEC values of 0.037 mg ai/L-pore water (*Chironomus riparius;* see **Table 22**)						

5.1.2 Risks to Aquatic Plants

Risk quotients calculated for vascular and non-vascular aquatic plants using the crop exposure scenario with the highest acute and chronic EECs in surface water (NC cotton) are provided **Table 33.** None of the risk quotients exceed the LOC for listed or non-listed aquatic plant species.

Table 33. Maximum acute and chronic risk quotients for non-vascular and vascular aquatic plants

Use Category	Crop Scenario	Peak EEC (mg/L) [1]	Non-Vascular Plant RQ [2]		Vascular Plant RQ [3]	
			Non-Listed	Listed	Non-Listed	Listed
Cotton	NC Cotton	0.0530	<0.0007	0.02	<0.0005	0.0005

[1] For screening purposes, these EECs are based on total residues of interest (parent + X-474 + X-540).
[2] RQ values for non-listed and listed non-vascular aquatic plants are based on the peak surface water EEC / EC_{50} value of >95.6 mg ai/L and a 96-h NOAEC of 3.54 mg ai/L, respectively (freshwater diatom, *Navicula pelliculosa*; see **Table 22**)
[3] RQ values for non-listed and listed vascular aquatic plants are based on the peak surface water EEC / 7-d EC_{50} value of >99 mg ai/L and a 7-d NOAEC of 99 mg ai/L, respectively (Duckweed (*Lemna gibba;* see **Table 22**)

5.1.3 Risks to Terrestrial Animals

Potential risks to mammals and birds are derived using T-REX (version 1.5) with biological inputs including: 1) acute and chronic toxicity data for the rat and mallard, 2) weights of three mammalian and avian size classes, and 3) various dietary categories being consumed. Chemical-specific inputs include: 1) application rate, 2) application interval, 3) frequency of applications, and a chemical-specific foliar dissipation rate of 12.3 days.

For sulfoxaflor, the proposed use pattern encompasses four different modeling scenarios for T-REX:

- **2 x 0.133 lb ai/A @ 7 d interval** (citrus, fruits-pome, fruits-stone, ornamentals, tree nuts, turf grass)
- **3 x 0.090 lb ai/A @ 7 d interval** (beans, berries, soybeans, veg.-brassica, veg.-bulb, veg.-leafy, veg.-root/tuber, veg.-fruiting, veg.-cucurbit, watercress)
- **3 x 0.090 lb ai/A @ 5 d interval** (cotton), and
- **2 x 0.043 lb ai/A @ 14-d intervals** (canola and grains)

Of these exposure scenarios, the first (2 x 0.133 lb ai/A @ 7 d interval) yields the highest residues on terrestrial forage items. Therefore, it is used here as an initial screen for evaluating whether the proposed uses of sulfoxaflor have potential risks to avian and mammalian wildlife.

5.1.3.1. Acute Risk to Mammals

Acute mammalian RQ values are calculated using the rat acute oral toxicity data (LD_{50} =1000 mg/kg b.w.) adjusted for differences in body weight for a small (15g), medium (35g) and large (1000g) mammal by T-REX (adjusted LD_{50} =2198, 1778, and 769 mg/kg b.w., respectively) and the modeled acute dose-based EECs for various use scenarios and diet categories. Results from the application scenario providing the highest residues on forage items (Citrus, Fruits-Pome, Fruits-Stone, Ornamentals, Tree nuts, Turf grass) are provided in **Table 34.** These results are based on the 90th percentile foliar dissipation half life of 12.3 days for sulfoxaflor. Maximum acute mammalian RQ values are all below 0.1 which indicates a low acute risk potential to listed and non-listed mammals consuming the modeled forage items.

Table 34. Maximum acute dose-based risk quotients for mammals

Size Class (g)	Adjusted LD_{50} (mg/kg-bw)	EECs (mg a.i./kg bw) and RQs[1,2]											
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/ Seeds		Arthropods		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
2 x 0.133 lb ai/A, 7 d Interval (Citrus, Fruits-Pome, Fruits-Stone, Ornamentals, Tree nuts, Turf grass													
15	2198	51.0	0.02	23.2	0.01	28.7	0.01	3.2	0.00	20.0	<0.01	0.71	<0.01
35	1778	35.2	0.02	16.1	0.01	19.8	0.01	2.2	0.00	13.8	<0.01	0.49	<0.01
1000	769	8.2	0.01	3.7	< 0.00	4.6	0.01	0.5	0.00	3.2	<0.01	0.11	<0.01

[1] EECs calculated using T-REX based on sulfoxaflor-specific foliar dissipation half life of 12.3 days.
[2] Acute RQ values calculated as EEC/size class-adjusted LD50 based on unadjusted LD50 of 1000 mg a.i./kg bw for the rat (MRID 47832144).

5.1.3.2. Chronic Risks to Mammals

Potential chronic risks to mammals are derived using a dietary-based NOAEL of 100 ppm from a 2-generation reproduction study with the rat (MRID 47832142) and EECs for the crop exposure scenario yielding the maximum residues on forage items (2 x 0.133 lb ai/A). The chronic dietary-based RQ values range from **0.03** (Fruits, pods, seeds, large insects) to **0.5** (short grass). Since these chronic RQ values are all below the chronic risk LOC of 1.0, the potential for chronic risks to mammals is based on a dietary approach is considered low (**Table 35**).

Table 35. Maximum chronic diet-based risk quotients for mammals

NOAEC (ppm in diet)	EECs (ppm diet) and RQs[1,2]									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds /Large Insects		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
	2 x 0.133 lb ai/A, 7 d Interval (Citrus, Fruits-Pome, Fruits-Stone, Ornamentals, Tree nuts, Turf grass)									
100	53.4	0.53	24.5	0.24	30.1	0.30	3.3	0.03	20.9	0.21

[1] EECs calculated using T-REX based on sulfoxaflor-specific foliar dissipation half life of 12.3 days.
[2] Chronic RQ values calculated based on the dietary EEC / NOAEC of 100 ppm in the diet (MRID 47832142

Potential chronic risks to mammals are also evaluated using a dose-based approach which relies on a NOAEL of 6.07 mg a.i./kg bw/d from the same 2-generation toxicity rat study (MRID 47832142). This dose-based NOAEL is adjusted in the T-REX model to account for different size classes of mammals. Specifically, body-weight adjusted NOAELs of 13.3, 10.8, and 4.7 mg a.i./kg bw/d were calculated 15g, 35g and 1000g mammals, respectively. These adjusted values are used to interpret the dose-based EECs calculated for the same mammalian size classes. The overall range in chronic RQ values is from **0.01 to 3.8**, and the potential for chronic risks to mammals is identified for all crop scenarios for at least one dietary category (**Table 36**).

Table 36. Chronic dose-based RQ values for mammals

Size Class (g)	Adjusted NOAEL (mg a.i./kg bw/d)	EECs (mg a.i./kg bw/d) and RQs[1,2]											
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/ Seeds		Arthropods		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
2 x 0.133 lb ai/A, 7 d Interval (Citrus, Fruits-Pome, Fruits-Stone, Ornamentals, Tree nuts, Turf grass													
15	13.3	50.9	**3.8**	23.4	**1.8**	28.7	**2.1**	3.2	0.24	20.0	**1.5**	0.71	0.05
35	10.8	35.2	**3.3**	16.1	**1.5**	19.8	**1.8**	2.2	0.20	13.8	**1.3**	0.49	0.05
1000	4.7	8.2	**1.7**	3.7	0.80	4.6	0.98	0.51	0.11	3.2	0.68	0.11	0.02
3 x 0.090 lb ai/A, 7 d Interval (Beans, Berries, Soybeans, Veg.-Brassica, Veg.-Bulb, Veg.-Leafy, Veg.-Root/Tuber, Veg.-Fruiting, Veg.-Cucurbit, Watercress)													
15	13.3	47.9	**3.6**	21.9	**1.6**	26.9	**2.0**	3.0	0.22	18.7	**1.4**	0.66	0.05
35	10.8	33.1	**3.1**	15.2	**1.4**	18.6	**1.7**	2.1	0.19	13.0	**1.2**	0.46	0.04
1000	4.7	7.7	**1.6**	3.5	0.75	4.31	0.92	0.48	0.10	3.0	0.64	0.11	0.02
3 x 0.090 lb ai/A, 5 d Interval (Cotton)													
15	13.3	53.4	**4.0**	24.5	**1.8**	30.0	**2.3**	3.3	0.25	20.9	**1.6**	0.74	0.06
35	10.8	36.9	**3.4**	16.9	**1.6**	20.8	**1.9**	2.3	0.21	14.5	**1.3**	0.51	0.05
1000	4.7	8.6	**1.8**	3.9	0.84	4.8	**1.0**	0.53	0.11	3.4	0.72	0.12	0.03
2 x 0.043 lb ai/A, 14-d Intervals (Canola, Grains)													
15	13.3	14.3	**1.1**	6.6	0.49	8.0	0.60	0.89	0.07	5.6	0.42	0.20	0.01
35	10.8	9.9	0.92	4.5	0.42	5.6	0.52	0.62	0.06	3.9	0.36	0.14	0.01
1000	4.7	2.3	0.49	1.1	0.23	1.3	0.28	0.14	0.03	0.90	0.19	0.03	0.01

Size Class (g)	Adjusted NOAEL (mg a.i./kg bw/d)	EECs (mg a.i./kg bw/d) and RQs[1,2]											
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/ Seeds		Arthropods		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ

[1] EECs calculated using T-REX based on sulfoxaflor-specific foliar dissipation half life of 12.3 days.
[2] Chronic dose-based RQ values calculated as dietary EEC / size class-adjusted NOAEC based on an unadjusted NOAEC of 6.7 mg/kg bw/d (MRID 47832142)
RQ values shown in **bold** exceed the chronic risk LOC of 1.0

5.1.3.3. Acute Risk to Birds

For sulfoxaflor, avian dose-based acute RQs are based on the zebra finch acute oral toxicity data (LD_{50} > 80 mg a.i./kg bw; MRID 47832072) which reflects the concentration above which dose-dependent effects of regurgitation were observed. Thus, a value of 80 mg a.i./kg bw is used as a conservative screen for acute risks to birds. Acute dose-based RQ values are based on LD_{50} values adjusted differences in body weight for birds (20, 100, 1000g) (adjusted LD_{50} =86.4, 110 and 155 mg a.i./kg bw, respectively) and modeled acute dose-based EECs for various use scenarios and diet categories and a sulfoxaflor-specific foliar DT_{50} of 12.3 days.

Avian acute RQs for sulfoxaflor are shown in **Table 37**. The overall range in acute RQ values is from <**0.01 to 0.70**, and the potential for acute risks to birds (including reptiles and terrestrial-phase amphibians) is identified for all crop scenarios for at least one dietary category

Table 37. Acute dose-based risk quotients for birds

Size Class (g)	Adjusted LD_{50} (mg a.i./kg-bw)	EECs (mg a.i./kg-bw) and RQs*											
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
2 x 0.133 lb ai/A, 7 d Interval (Citrus, Fruits-Pome, Fruits-Stone, Ornamentals, Tree nuts, Turf grass)													
20	86.4	60.9	**<0.70**	27.9	**<0.32**	34.2	**<0.40**	3.8	<0.04	23.8	**<0.28**	0.85	<0.01
100	110	34.7	**<0.32**	15.9	**<0.14**	19.5	**<0.18**	2.2	<0.02	13.6	**<0.12**	0.48	<0.00
1000	155	15.5	**<0.10**	7.1	<0.05	8.7	<0.06	0.97	<0.01	6.1	<0.04	0.22	<0.00
3 x 0.090 lb ai/A, 7 d Interval (Beans, Berries, Soybeans, Veg.-Brassica, Veg.-Bulb, Veg.-Leafy, Veg.-Root/Tuber, Veg.-Fruiting, Veg.-Cucurbit, Watercress)													
20	86.4	57.2	**<0.66**	26.2	**<0.30**	32.2	**<0.37**	3.6	<0.04	22.4	**<0.26**	0.79	<0.01
100	110	32.6	**<0.30**	14.9	**<0.14**	18.3	**<0.17**	2.0	<0.02	12.8	**<0.12**	0.45	<0.01
1000	155	14.6	<0.09	6.7	<0.04	8.2	<0.05	0.91	<0.01	5.7	<0.04	0.20	<0.01
3 x 0.090 lb ai/A, 5 d Interval (Cotton)													
20	86.4	63.8	**<0.74**	29.2	**<0.34**	35.9	**<0.42**	4.0	<0.05	25.0	**<0.29**	0.89	<0.01
100	110	36.4	**<0.33**	16.7	**<0.15**	20.5	**<0.19**	2.3	<0.02	14.2	**<0.13**	0.51	<0.01
1000	155	16.3	**<0.10**	7.5	<0.05	9.2	<0.06	1.0	<0.01	6.4	<0.04	0.23	<0.01
2 x 0.043 lb ai/A, 14-d Intervals (Canola, Grains)													

Size Class (g)	Adjusted LD_{50} (mg a.i./kg-bw)	EECs (mg a.i./kg-bw) and RQs*											
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
20	86.4	17.1	**<0.20**	7.8	<0.09	9.6	**<0.11**	1.1	<0.01	6.7	<0.08	0.24	<0.01
100	110	9.7	<0.09	4.5	<0.04	5.5	<0.05	0.61	<0.01	3.8	<0.03	0.14	<0.01
1000	155	4.4	<0.03	2.0	<0.01	2.5	<0.02	0.27	<0.00	1.7	<0.01	0.06	<0.01

[1] EECs calculated using T-REX based on sulfoxaflor-specific foliar dissipation half life of 12.3 days.
[2] Acute RQ values calculated as EEC/size class-adjusted LD50 based on unadjusted LD50 of 80 mg a.i./kg bw for the zebra finch (MRID 47832072)
RQ values shown in **bold** exceed the acute risk to listed species LOC of 0.1

Avian subacute dietary-based acute risk quotients for the crop scenario resulting in the maximum residues on forage items are provided in **Table 38**. These RQ values are based on the dietary LC_{50} of 5,620 ppm diet for the mallard duck (MRID 47832104) and a sulfoxaflor-specific foliar dissipation half life of 12.3 days. No subacute acute risk is identified with the dietary-based approach, as RQ values are all well below the acute risk to listed species LOC of 0.1.

Table 38. Maximum acute diet-based risk quotients for birds

LC_{50} (ppm diet)	EECs (ppm in diet) and RQs[1,2]									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
	2 x 0.133 lb ai/A, 7 d Interval (Citrus, Fruits-Pome, Fruits-Stone, Ornamentals, Tree nuts, Turf grass									
5620	53.44	0.01	24.49	<0.01	30.06	0.01	3.34	<0.01	20.93	<0.01

[1] EECs calculated using T-REX based on sulfoxaflor-specific foliar dissipation half life of 12.3 days.
[2] Acute RQ values calculated as EEC/subacute LC50 of 5,620 ppm diet for mallard (MRID 47832104)

Potential chronic effects to terrestrial birds (including reptiles and terrestrial-phase amphibians) are derived by considering highest dietary-based EECs modeled in T-REX for a bird consuming a variety of dietary items. Chronic effects are estimated using the lowest available chronic dietary toxicity data for birds (NOAEC= 200 mg/kg-diet for mallard duck) and a sulfoxaflor-specific foliar dissipation half life of 12.3 days. Chronic dietary-based RQs range from **0.02 to 0.27** (**Table 39)**, thus indicating a low potential for chronic risks to birds.

Table 39. Maximum chronic diet-based risk quotients for birds

NOAEC (ppm)	EECs and RQs[1, 2]									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
	2 x 0.133 lb ai/A, 7 d Interval (Citrus, Fruits-Pome, Fruits-Stone, Ornamentals, Tree nuts, Turf grass									
200	53.44	0.27	24.49	0.12	30.06	0.15	3.34	0.02	20.93	0.10

[1] EECs calculated using T-REX based on sulfoxaflor-specific foliar dissipation half life of 12.3 days.
[2] Chronic RQ values calculated as EEC/dietary NOAEC of 100 ppm diet for the rat (MRID 47832142)

5.1.3.4. Non-target Terrestrial and Semi-Aquatic Plants

For sulfoxaflor, the NOAEC values from seedling emergence and vegetative vigor toxicity tests of terrestrial plants are above the maximum single application rate of 0.133 lb ai/A (MRID 47832425 and 47832427) . Therefore, a low potential for risk to listed and non-listed terrestrial plants is expected based on the proposed use profile for sulfoxaflor.

5.1.3.5. Risk Estimation for Bees

Figure 15 illustrates the proposed decision-making process for assessing risks to honey bees associated with foliar spray applications of pesticides (*e.g.*, via ground and aerial methods) including systemic pesticides such as sulfoxaflor. This decision-making framework was recently presented and reviewed by a FIFRA Scientific Advisory Panel.[17] The overall proposed approach is a tiered process whereby risks are first assessed using simple and conservative exposure screening models to generate estimated environmental concentrations (EECs) (**Boxes 3a**, **3b** and **3c** of **Figure 15**) coupled with toxicity estimates derived from laboratory studies (Tier I) to calculate risk quotients (RQs) (**Boxes 4a**, **4b** and **4c**). Results from the Tier I risk assessment process are expected to be reasonably conservative such that the likelihood of a false negative is low (*i.e.*, the chance that no risk is indicated but risks actually occur), while at the same time ensuring that the likelihood of a false positive (*i.e.*, the chance that risk is indicated when none actually exists) is not unacceptably high. For example, the initial exposure estimates used in Tier I are generally not chemical-specific, but rather reflect upper-bound estimates that would encompass exposures across all relevant pesticide uses. If risks are identified in Tier I (*i.e.*, where risk estimates exceed levels of concern[18]; **Box 5**), additional data may be used to refine the results, such as using estimates of exposure derived from available magnitude of residue or other commonly submitted studies (**Box 6)**.

If risks are still identified after refinement with available data (**Box 7**), then appropriate risk mitigation options would be identified and further evaluated for their impact on risk estimates (**Box 8**). Alternatively (or in addition), a higher tier assessment may be necessary (Tier II) and studies providing refined estimates of exposure (*e.g.*, field studies quantifying residues in pollen and nectar; **Box 9a**) and effects at the colony level (*e.g.*, semi-field tunnel studies or field-level feeding studies; **Box 9b**) may be requested. Measured residues in pollen and nectar (**Box 9a**) from these studies may be used to refine risk estimates from Tier I (**Box 6**) and/or for qualitatively evaluating risk at the colony level associated with pesticide applications (**Box 10**). They may also be used to identify more targeted risk mitigation options than those that could be identified based on Tier I risk estimates.

Although not specifically depicted in **Figure 15** for foliar applications, data from the toxicity of residues on foliage study are used qualitatively to characterize the length of time that residues

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[17] http://www.epa.gov/scipoly/sap/meetings/2012/091112meeting.html).
[18] As described in USEPA (2012), an acute risk level of concern of 0.4 is proposed for the honey bee.

remain toxic to bees. The results of the guideline study may result in precautionary label statements similar to those discussed in the EPA Label Review Manual (USEPA 2012) or in guidance documents intended to reduce the potential effects of pesticides on bees (*e.g*., Riedl *et al*. 2006).

If available risk mitigation options (**Box 11**) do not provide for an acceptable reduction in risk, proceeding to Tier III (**Box 12**) may be necessary to resolve specific uncertainties identified from Tiers I and II for the proposed uses of the pesticide. For example, effects on the ability of colonies to successfully emerge in the spring (*e.g*., produce sufficient brood and adult bees after over-wintering) may be a concern for some pesticides/uses which are not typically addressed in earlier tiers.

The risk assessment process depicted in **Figure 15** is intended to be iterative and to rely on multiple lines of evidence to further refine and characterize potential risk. At a screening level, risk to individual bees is quantified through the use of RQ values. Where RQ values exceed the LOC, more refined estimates of exposure may be used to re-evaluate RQ values for individual bees based on laboratory toxicity estimates. Where RQs still exceed LOCs, higher tier semi-field and full-field studies may be required to determine whether effects observed under highly controlled conditions extend to the whole colony under increasingly realistic exposure conditions.

As depicted in **Figure 15,** if the multiple lines of evidence indicate that unacceptable effects on survival, growth or reproduction of the colony are not likely, then a presumption of minimal risk can be supported. Alternatively, there may be situations where colony-level effects may be likely, given the proposed use or known mode of action of a compound. In this case, a presumption of minimal risk cannot be supported, and risk assessors should attempt to characterize the nature and possible magnitude and duration of the effect. This characterization should include a discussion of uncertainties which limit the extent to which the possible magnitude and duration can be estimated. Also, the risk characterization should include any potential mitigation options for minimizing risk to bees from the proposed use of a pesticide.

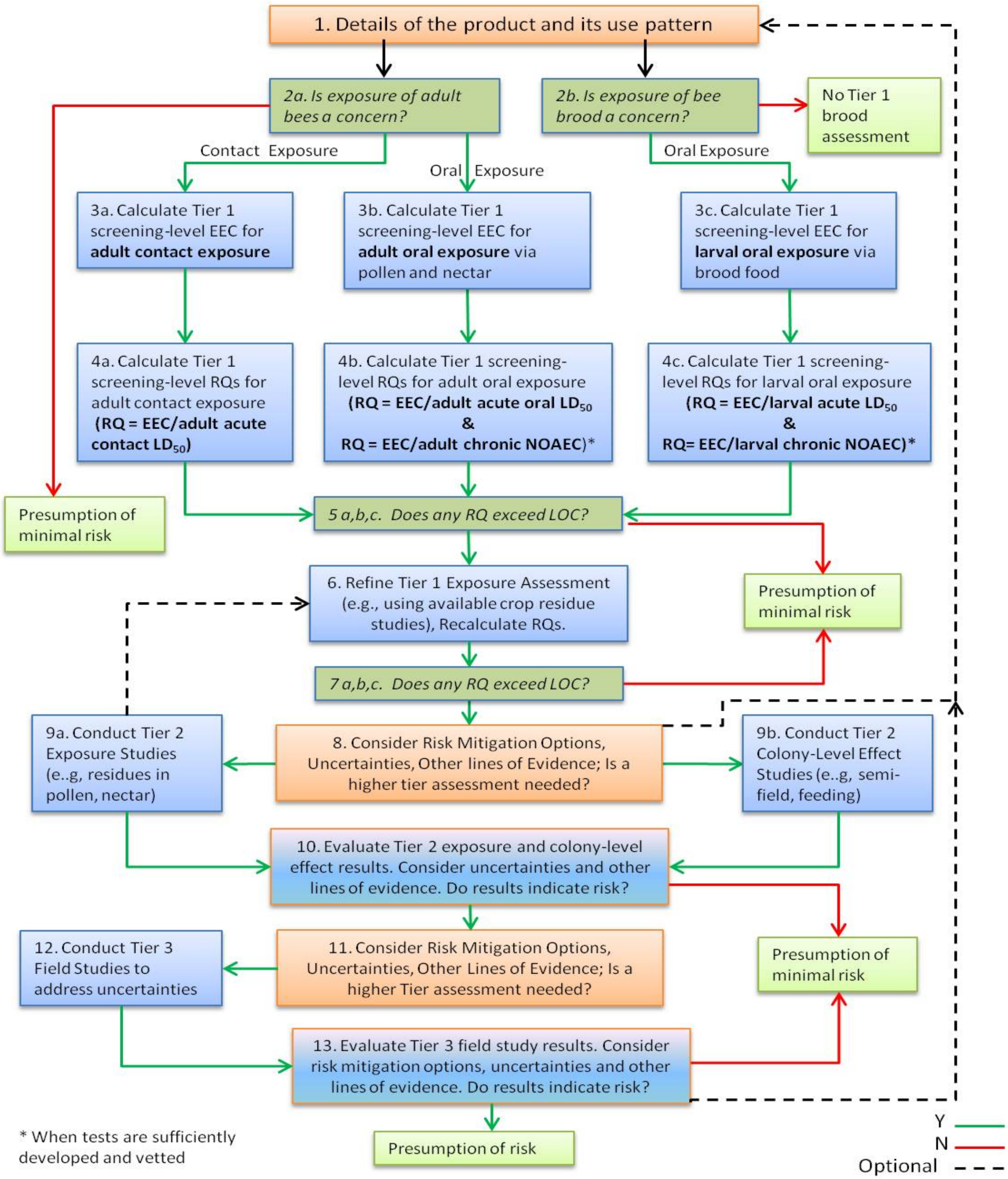

Figure 15. Proposed Tiered Approach for Assessing Risk to Honey Bees from Foliar Spray Applications

a) Tier 1 Risk Estimation for Honey Bees

For the initial Tier 1 screen, two exposure routes are considered: dietary and contact. **Table 40** summarizes the initial residue values expressed in units of μg a.i./bee per 1 lb a.i./A. As discussed below, these values are adjusted to account for the application rate of the chemical. For generating RQs, dietary based exposure values are compared to oral toxicity data for larvae and adult worker bees while contact exposure values are compared to acute contact toxicity data for adult worker bees.

As indicated in **Table 40,** the initial screening-level RQs exceed the proposed LOC of 0.4 for adults (oral and contact) exposures. Therefore, additional refinement of the Tier 1 exposure estimates is warranted.

Table 40. Tier I exposure values of honey bees to pesticides applied via foliar applications

Life Stage	Exposure Type	Dose (μg a.i./bee per 1 lb a.i./A)(1)	Sulfoxaflor Dose for Max Application Rate (μg a.i./bee per 0.133 lb a.i./A)	Acute RQ)(2)(3)	Chronic RQ)(3)
Adult	Diet (nectar + pollen)	32	4.3	**83**	n.a.
Adult	Direct contact	2.7	0.72	**2.8**	n.a.

(1) Source: USEPA 2012. Draft Pollinator Risk Assessment Framework
(2) Based on a 48-h acute oral LD_{50} of 0.0515 ug ai/bee for GF-2032 (MRID 47832417) and acute contact LD_{50} of 0.130 ug ai/bee for GF-2032 (MRID 47832419).
(3) **Bolded** value exceeds the acute risk LOC of 0.4

b) Refined Tier 1 Risk Estimation for Honey Bees

Sulfoxaflor Residue Studies

As indicated in **Box 6** of **Figure 15**, refinements of Tier 1 risk estimation for oral exposure can be accomplished by using chemical-specific data on residues in pollen and nectar. For sulfoxaflor, such residue data are available from multiple studies including a field residue study with cotton (MRID 48755606), pumpkin (MRID 48755601) and *Phacelia* (MRID 48446601 and 48445806). Maximum reported residues in various plant and hive matrices are shown in **Table 41.** Details of these studies are provided in **Appendix D.**

Table 41. Maximum reported residues (ppm) of sulfoxaflor in plant and hive materials from various field studies

Application Rate (lb ai/A)	Plant Pollen*	Plant Nectar	Plant Tissue	Forager Nectar*	Forager Pollen	Comb Pollen	Comb Larvae	MRID
Cotton								
1 x 0.045	1.26			0.13	0.22	0.03	<0.01	48755606
2 x 0.045	2.54			0.05	0.83	0.04	0.01	
2 x 0.089	**6.66**			0.07	2.78	1.19	0.03	
2 x 0.134	2.61			**1.01**	2.23	0.04	0.08	

Application Rate (lb ai/A)	Plant Pollen*	Plant Nectar	Plant Tissue	Forager Nectar*	Forager Pollen	Comb Pollen	Comb Larvae	MRID
Phacelia								
1 x 0.021			0.52[b]	0.05	0.29			48446601
1 x 0.043			1.48[b]	0.09	0.81			
Phacelia								
1 x 0.006						0.06[a]		48445806
1 x 0.012						0.04[a]		
1 x 0.021			1.76[b]			0.61[a]		
1 x 0.045						0.23[a]		
1 x 0.088						1.01[a]		
Pumpkin								
1 x 0.022	0.08	0.03	0.20[b]					48755601
1 x 0.089	0.38	0.03	1.27[b]					

[a] Samples taken 7 days after treatment rather than immediately after treatment
[b] Whole plant samples in 48446601, flower samples in 48445806, leaf tissue in 48755601
* Overall maximum reported residue in pollen and nectar used for Tier 1 risk assessment is shown in bold

Honey Bee Pollen and Nectar Consumption Rates

Estimation of honey bee consumption of pollen and nectar depends on the caste and life stage of the bee. Consumption rates for different castes, life stages and tasks of honey bees have been recently reviewed and summarized in USEPA (2012). A summary of these consumption rate estimates is found in **Appendix D**. As indicated in **Table 42,** the highest consumption rates for worker, drone, and queen larvae occur on the last days of their life stage. Therefore, for Tier 1 risk assessment purposes, the latter two days of the worker and drone pollen and nectar consumption rates is used for calculating oral doses of sulfoxaflor. Feedback from the FIFRA SAP on the draft pollinator risk assessment framework indicated that consumption rates should be summed across the entire larval life stage. It is noted here that assessment of doses of sulfoxaflor in royal jelly is not conducted because available data indicate residues in royal jelly are reduced by 100X or greater presumably due to processing of material by nurse bees (Davis and Shuel 1988 and Kamel *et al*. (unpublished)). Estimated consumption rates for adult honey bees are provided in **Table 43**.

Table 42. Estimated consumption rates of pollen, nectar and royal jelly by larval honey bees

Life Stage	Caste	Average age (in days)*	Daily consumption rate (mg/day)			
			Brood food / royal jelly	Nectar**	Pollen***	Total food
Larval	Worker	1	3.75	none	none	3.75
		2	7.50	none	none	7.50
		3	15	none	none	15
		4	none	37	2.7	40
		5	none	77	2.7	80

Life Stage	Caste	Average age (in days)*	Daily consumption rate (mg/day)			
			Brood food / royal jelly	Nectar**	Pollen***	Total food
		Days 4+5	**none**	**114**	**5.4**	**119**
	Drone	5	none	52	unknown	52
		6	none	100	unknown	100
		Days 5+6	**none**	**152**	**Unknown**	**152**
	Queen	1	9.4	none	none	9.4
		2	19	none	none	19
		3	38.0	none	none	38
		4	100.0	none	none	100
		5	203	none	none	203

Source: USEPA 2012 Draft Pollinator Risk Assessment Framework; highlighted row indicates consumption rate estimates used for the refined Tier 1 risk assessment;
NA = not applicable
*From Winston 1987
**From Rortais *et al.* 2005. Assumes that average sugar content of nectar is 30%.
*** From Crailsheim et al. (1992, 1993).

Table 43. Estimated consumption rates of pollen, nectar and royal jelly by adult honey bees

Life Stage	Caste	Daily consumption rate (mg/day)				
		Average Age (in days)	Brood food / royal jelly	Nectar**	Pollen***	Total food
Adult	Worker (cell cleaning and capping)	0-10	none	60	5.2	65
	Worker (brood and queen tending, nurse bees)	6-17	none	140	8.85	149
	Worker (comb building, cleaning and food handling)	11-18	none	60	1.7	62
	Worker (foraging for pollen)	>18	none	43.5	0.041	44
	Worker (foraging for nectar)	>18	none	292	0.041	292
	Worker (maintenance of hive in winter	0-90	none	29	2	31
	Drone	>10	none	235	0.0002	235
	Queen	0+	Unknown	unknown	None	unknown

Source: USEPA 2012 Draft Pollinator Risk Assessment Framework;
NA = not applicable
*From Winston 1987
**From Rortais *et al.* 2005. Assumes that average sugar content of nectar is 30%.
*** From Crailsheim et al. (1992, 1993).

Honey Bee Oral Dose Estimation

By combining the maximum reported residues of sulfoxaflor in pollen and nectar with the estimated consumption rates shown in **Table 42** and **Table 43**, a total oral dose is estimated. This oral dose is then divided by the applicable acute oral LD_{50} (0.0515 µg ai/bee for adult workers and >0.2 µg ai/bee for larvae, respectively) to derive the acute RQ values (**Table 44**). Chronic toxicity data of sulfoxaflor to honey bees are not available nor have standardized test protocols for chronic toxicity testing of individual bees been developed. As indicated in **Table 44**, RQs range from **<0.8 to 5.7** and exceed the LOC for acute risk (0.4). This indicates that risk to honey bee colonies cannot be precluded and analysis of effects at the whole hive level is warranted (Tier 2). Unlike Tier 1, where risks are expressed quantitatively in the form of RQ values, risk in Tier 2 is described qualitatively and is characterized in **Section 5.2, Risk Description.**

Table 44. Refined Tier 1 oral risk quotients for honey bees using maximum reported concentrations in pollen and nectar

Life Stage	Cast/Task	Average Age (d)	Total food Consumption (mg/d)	Estimated Oral Dose (ug ai/bee/d)[1]	Acute RQ[2, 3]
Larvae	Worker	days 4+5	119	0.151	**<0.8**
	Drone	Days 5+6	152	0.153	**<0.8**
Adult	Worker (cell cleaning and capping)	0-10	65	0.095	**1.8**
	Worker (brood and queen tending, nurse bees)	6-17	149	0.200	**3.9**
	Worker (comb building, cleaning and food handling)	11-18	62	0.072	**1.4**
	Worker (foraging for pollen)	>18	43.5	0.044	**0.9**
	Worker (foraging for nectar)	>18	292	0.294	**5.7**
	Worker (maintenance of hive in winter	0-90	31	0.042	**0.8**
	Drone	>10	235	0.236	**4.6**
	Queen	0+	unknown	unknown	unknown

[1] Oral dose determined using maximum concentrations of sulfoxaflor in pollen (6.6 mg/kg) and nectar (1.0 mg/kg) reported in **Table 41** multiplied by the estimated cast-specific consumption rate.
[2] Acute RQs determined as the ratio of oral dose to the acute LD_{50} for adult (0.0515 µg ai/bee) and larval (>0.2 µg ai/bee) honey bees
[3] RQ values in **bold** exceed the proposed acute risk LOC of 0.4.

Based on the estimate median consumption rates of pollen and nectar shown in **Table 42** and **Table 43**, it is clear that the oral exposure of adult and larval honey bees is dominated by the consumption of nectar, with more than 90% of the total consumed food source represented by nectar. Given the importance of nectar as a source of food and potential contaminant exposure, the concentration in nectar necessary to meet or exceed the proposed acute risk LOC of 0.4 was determined. Based on the acute LD_{50} of 0.0515 µg a.i./bee and a consumption rate of 292 mg/d for adult nectar foragers, a concentration of $\geq$ **0.07 ppm** in nectar would result in an acute oral RQ that meets or exceeds the proposed LOC of 0.4. The adult nectar forager caste was chosen because it has the highest estimated nectar consumption rate among the various castes assessed. A comparison of each of the 88 reported residues of sulfoxaflor in cotton nectar reveals that only 4 values (5%) exceeded the 0.07 ppm LOC-based threshold (**Figure 16**). Three of these values are within a factor of two, but one value (1.0 ppm, day 8, 2 x 0.134 lb a.i./A, hive 1) is about 14X above the residue equivalent to the LOC. The vast majority of sulfoxaflor residues in nectar (88%) are less than half the 0.07 ppm LOC-based threshold in nectar. While the concentration of sulfoxaflor in pollen would add to the total dose estimated for nectar foragers, bees, the contribution is very minor and does not affect this interpretation of the results.

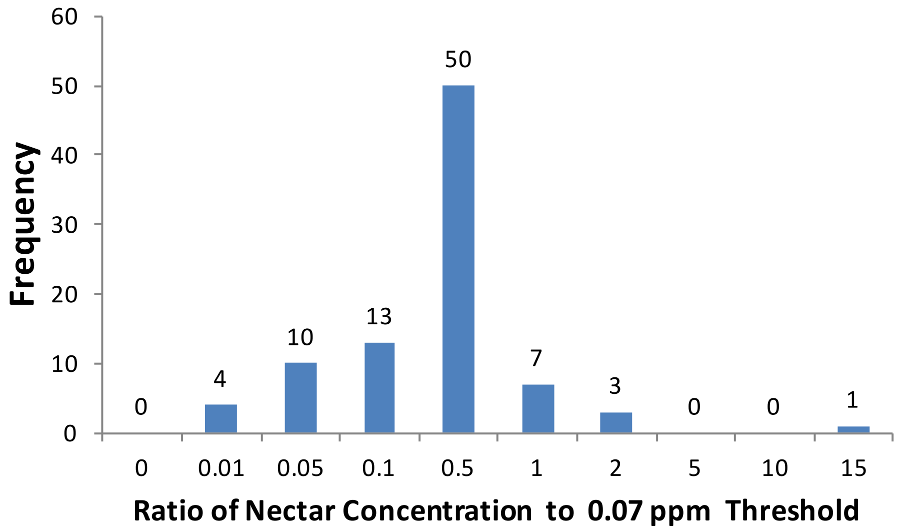

Figure 16. Ratio of sulfoxaflor concentration in cotton nectar to residue associated with the proposed acute LOC of 0.4

5.2 Risk Description - Interpretation of Direct Effects

In risk description, the results from the risk estimation are interpreted and synthesized into overall risk conclusions. This description considers other lines of evidence (*e.g.*, monitoring data, field data, refined exposure and effects modeling) for characterizing ecological risk. In addition, the risk description also contains a discussion of relevant sources of uncertainty in the risk assessment and sensitivity of the risk assessment findings to important methodological assumptions. The risk description also addresses other concerns including risks to threatened and endangered species, a discussion of uncertainty, and the sensitivity of risk conclusions to assumptions made in the assessment.

5.2.1 Risks to Aquatic Animals

A summary of the maximum sulfoxaflor acute and chronic RQ values derived for aquatic animals is shown in **Table 45**. None of these RQ values exceed the applicable acute or chronic risk LOC. Specifically, the acute RQ values are one to two orders of magnitude below the acute risk to listed species LOC of 0.05. The chronic RQ values are one to three orders of magnitude below the LOC, with the exception of saltwater invertebrates, which are within a factor of two of the LOC of 1.0. As discussed in Section 4, chronic RQ for saltwater invertebrates (benthic and water column-dwelling) is based on a NOAEC value for mysid shrimp (0.11 mg a.i./L) that reflects just a 4.5% increase in time to first brood relative to controls at the LOAEC of 0.25 mg a.i./L. No other adverse effects were reported at this concentration for mysid shrimp. Thus, there is some uncertainty regarding the biological significance of this endpoint and consequently, in the RQ values, which are just a factor of two below the chronic LOC.

Because sulfoxaflor is a new chemical, no information is available from monitoring data or ecological incident reports. Based on the results of risk estimation, the potential risk to aquatic animals from the proposed uses of sulfoxaflor is presumed low.

Table 45. Summary of aquatic animal risk profile for sulfoxaflor

Exposure	FW Fish RQ	SW Fish RQ	FW Invert. RQ (water column)	SW Invert. RQ (water column)	FW Invert. RQ (benthic)	SW Invert. RQ (benthic)
Acute	<0.0001	0.0002	<0.0001	0.009	<0.0001	0.006
Chronic	0.08	0.04	0.001	0.5	0.11	0.5
RQ values based on the maximum aquatic EECs derived from the NC Cotton exposure scenario; see Risk Estimation **Section 5.1** for derivation of these RQ values						

5.2.2 Risks to Aquatic Plants

Risk quotient values calculated using the maximum peek aquatic EEC and the lowest toxicity endpoint for aquatic vascular and non-vascular plants are two to three orders of magnitude below levels of concern (**Table 33).** This finding, combined with knowledge of the mode of action of sulfoxaflor (new class of nicotinic acetylcholine receptor agonist), support a conclusion of low potential risk to aquatic plants.

5.2.3 Risks to Terrestrial Organisms

5.2.3.1. Acute and Chronic Risk to Birds and Mammals

A summary of the overall acute and chronic risk profile for sulfoxaflor based on the exposure scenario producing the highest terrestrial EECs and the most sensitive species within each taxonomic group is shown in **Table 46.**

Table 46. Summary of the avian and mammalian risk profile for sulfoxaflor

Exposure	Avian Dose RQ	Avian Dietary RQ	Mammalian Dose RQ	Mammalian Dietary RQ
Acute	**<0.74**	0.01	0.02	n/a
Chronic	n/a	0.27	**3.8**	0.53

RQ values based on the maximum terrestrial EECs derived from 2 x 0.133 lb ai/A, 7 d interval exposure scenario; see Risk Estimation **Section 5.1** for derivation of these RQ values
* Refined RQ estimate using a foliar dissipation half life of 12.3 days
Bolded value exceeds chronic risk LOC

For birds (also used as a surrogate for terrestrial-phase amphibians and reptiles), a potential for acute risks is identified using the acute dose-based RQ approach. Specifically, a maximum RQ of <0.74 was determined using a sulfoxaflor-specific foliar dissipation half life of 12.3 days. Although a risk potential is indicated by this acute RQ, it is considered uncertain because the acute toxicity study upon which it is based (*i.e.*, zebra finch) failed to reach a definitive oral LD_{50} because birds regurgitated the dose. Because this regurgitation followed a dose-dependent response (with 20%-100% of the birds regurgitating at 80 mg a.i./kg bw and higher), regurgitation was judged to be a treatment-related response. Should such repellency be demonstrated in the wild with contaminated diet, ecologically relevant adverse effects could occur in absence of suitable (non-contaminated) forage items. Notably, 0% mortality occurred at doses of 132 mg a.i./kg-bw and lower, but 40% mortality occurred at 200 mg a.i./kg-bw, the highest dose tested. Since 100% of the birds regurgitated at this dose level, the actual exposure may be substantially lower and thus, the LD_{50} in absence of regurgitation may be lower than the highest dose tested. The conduct of another acute, dose-based study (or as an alternative, a dietary study) with passerines in which regurgitation was avoided would address this source of uncertainty in the avian acute risk estimation. In such a study, the acute oral LD_{50} would have to be greater than 560 mg a.i./kg bw in order for acute risks concerns to listed species not to be triggered (*i.e.*, RQ < 0.1).

For mammals, chronic risk concerns were identified based on reproductive effects identified at 24.6 mg/kg/d from a 2-generation reproductive toxicity study with the rat and modeled EECs for mammalian forage items. Based on the refined chronic dose-based RQ values presented in **Table 36,** chronic risk concerns were identified for all of the proposed sulfoxaflor uses for at least one dietary category which comprises four separate pesticide application scenarios. Chronic risk concerns were also identified for at least one dietary item with all size classes modeled (15, 35 and 1000g). However, it should be noted that a significant uncertainty associated with these chronic, dose-based RQ values pertains to the duration over which chronic effects to mammals are likely to be manifest. Specifically, these RQ values are derived using the maximum peak concentration of sulfoxaflor that is predicted to occur on dietary items. With a foliar half life of 12.3 days, predicted residues of sulfoxaflor on short grass would decline from a peak of 53.4 ppm (associated with an RQ of 3.8 for 15g mammal) to 14 ppm (associated with an chronic dose-based RQ of 1 for 15g mammal) in about 23 days. Over the 365 days in the T-REX simulation, predicted residues of sulfoxaflor remain above the 14 ppm level (> RQ of 1) for 30 days.

5.2.3.2. Risks to Terrestrial Plants

Risks to terrestrial plants from the proposed uses of sulfoxaflor are not expected based on available toxicity data which indicates that at or above the maximum application rate, no deleterious effects on plants was observed. This risk conclusion is also supported by the mode of action of sulfoxaflor, which would not be expected to affect plants at levels that would affect target insects.

5.2.3.3. Risks to Bees

a) Tier 1 Risk Assessment

As indicated in **Section 5.1.3.5 (Risk Estimation for Bees)**, the Tier 1 risk estimation indicates a potential risk to bees at the individual (organism) level through the acute, oral route of exposure using the maximum residues reported from available residue studies. Specifically, risks above the proposed acute risk LOC value were identified for all castes of bees modeled with the oral route of exposure (**Table 44**). Acute oral RQ values range from 0.8 to 5.7 across all castes of adult worker and larval bees examined.

A number of uncertainties associated with the Tier 1 risk estimation for sulfoxaflor are noted and further described in this section, with attention to how they may affect the tier 1 risk conclusion. These include:

- use of maximum residue reported in pollen and nectar to represent exposure to all bee casts and all crops
- lack of chronic toxicity data for adult and larval bees (and longer-term exposure to pupae)
- selection of the toxicity endpoint from the larval toxicity test (*e.g.*, NOAEC vs. LD_{50})
- accuracy of consumption rate estimates used for various bee castes
- variation in pesticide residues in pollen and nectar
- conservation of pesticide dose from plant tissue to the hive

Use of Maximum Reported Residues. As described in **Section 5.1.3.5**, the Tier 1 risk assessment for bees is based on the maximum reported residue of sulfoxaflor in pollen and nectar (6.6 and 1.0 ppm, respectively). These values were obtained from the cotton residue study using

application rates ranging from 0.045 to 0.134 lb a.i./A. Plots of this residue data are shown in **Figure 17** for sulfoxaflor residues in plant pollen (**Panel A**), forager-collected pollen (**Panel B**), and forager-collected nectar **(Panel C)** over the 10-d residue collection period.
For plant pollen, applications were made on Day 0 (all treatments) and Day 5 (three treatments). Residue data shown in **Panel A** of **Figure 17** indicate a rapid decline in sulfoxaflor concentrations in cotton pollen immediately following pesticide applications. This steep decline may be related to cotton flowers remaining open for pollination for approximately 1 day followed by withering, closure and drying on subsequent days (Ritchie *et al*., 2004; Smith, 2012). Therefore, samples taken from flowers between application days would represent flowers that were closed prior to pesticide applications. It is also worthy to note that an expected treatment-dependent trend in residue concentrations in plant pollen was not consistently seen in this study. This suggests that these data are subject to sources of variation that mask the expected trend of higher residues in plant pollen with higher pesticide application rate. Although selection of the maximum residue in plant pollen for Tier 1 risk assessment may reflect a level of conservatism in the assessment, the high variability in residue concentrations suggest that even the maximum observed concentration in pollen may not reflect the overall maximum residue in cotton plant pollen. Furthermore, results from sulfoxaflor residues measured in forager-collected pollen (**Panel B**) demonstrate that bees were repeatedly collecting pollen with 1-2 ppm. Use of these values instead of the 6.6 ppm maximum for pollen consumption would not alter the Tier 1 risk conclusions.

Regarding the selection of the maximum residue reported in nectar (1.0 ppm from hive 1 at2 x 0.134 lb a.i./A; **Appendix D**), results from **Figure 17 (Panel C)** indicate that this value is about an order of magnitude greater than the next highest concentration measured in nectar. Results shown in **Panel C** of **Figure 17** reflect mean values across two hives. Unexpectedly, this maximum concentration in nectar occurred in between application days (day 8), which likely reflects systemic translocation of sulfoxaflor from the prior applications on days 0 and 5. If the next greatest concentration of sulfoxaflor in nectar were used instead of the overall maximum (e.g., 0.1 vs. 1.0 ppm), risks to larvae would be below LOCs but those for adult foragers would still exceed the LOC of 0.4.

Lack of Chronic Toxicity Data. Another uncertainty in the Tier 1 risk assessment is lack of chronic toxicity endpoints for adult and larval bees. Although the submitted toxicity tests for honey bee larvae were intended to provide such information, limitations in the study design precluded use of results from beyond day 7 of these studies. Therefore, to the extent that adults and larvae are more sensitive to sulfoxaflor over greater exposure durations, results from this Tier 1 risk assessment will underestimate chronic risk to bees.

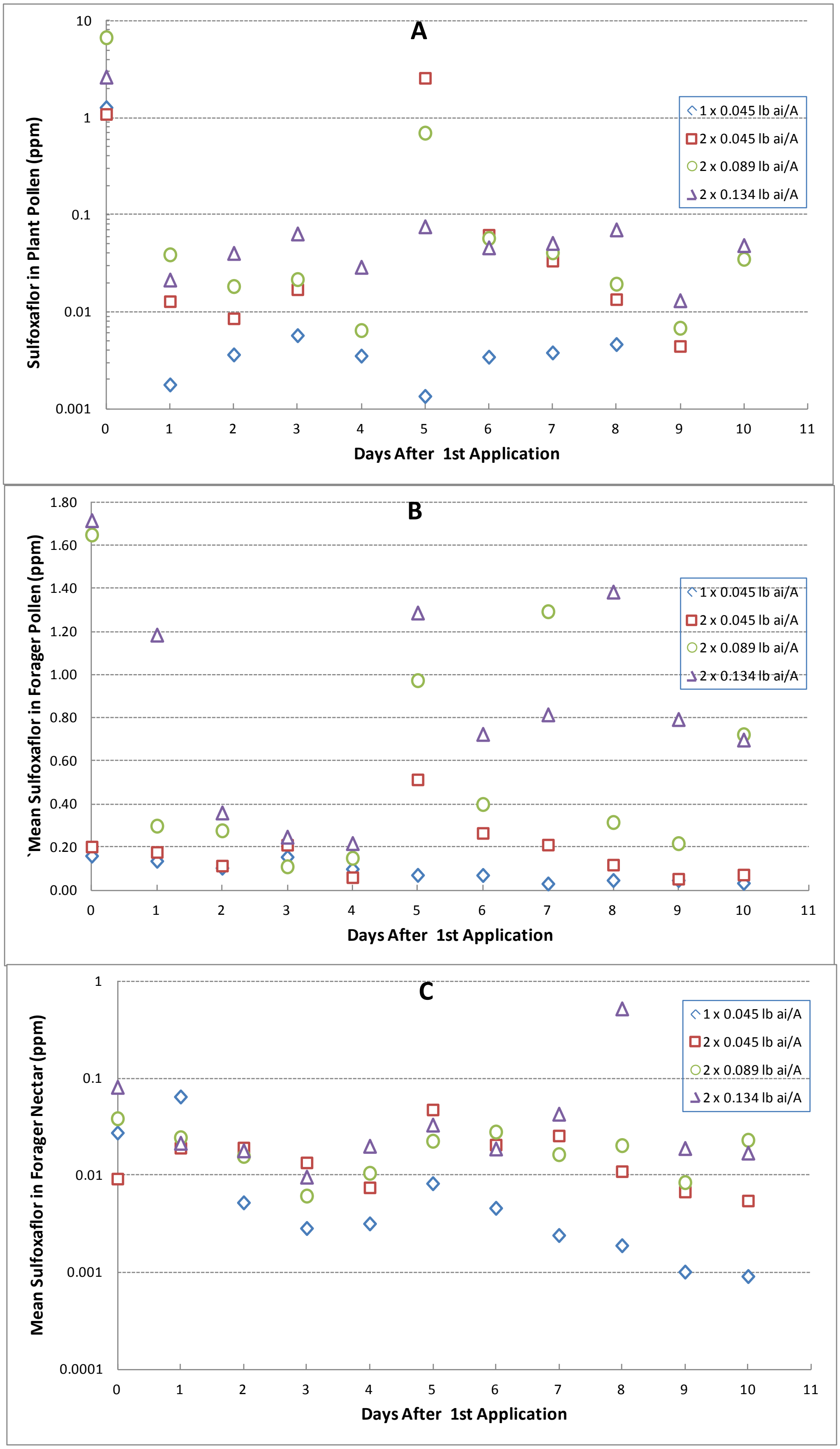

Figure 17. Sulfoxaflor residues in cotton plant pollen (A), forager-collected pollen (B) and forager collected nectar (C). Forager-collected pollen and nectar residues are a mean from bees at two hives in each tunnel (MRID 48755606).

Selection of Larval Toxicity Endpoint. As noted in Section 4, the larval toxicity endpoint selected for this analysis is >0.2 ug ai/bee. This value is a "non-definitive" LD_{50} because mortality at the highest test concentration (45%) did not exceed 50%. Although use of this non-definitive LD_{50} value introduces some uncertainty in the Tier 1 risk assessment, the close proximity of the mortality response (45%) to 50% suggests that the actual LD_{50} value would likely be relatively close to the 0.2 ug ai/bee value used in the assessment. The 7-d LD_{50} value would have to be more than a factor of 2 lower than 0.2 in order to change the risk conclusions for larval bees.

Consumption Rates of Pollen and Nectar. The consumption rate estimates of pollen and nectar used for Tier 1 risk assessment are subject to considerable variability and uncertainty, as described in USEPA (2012). However, values represent median estimates (rather than high-end) in order to avoid compounding multiple conservative assumptions on the risk assessment results. Since nectar consumption rates drive the Tier 1 risk estimates for adult nectar foragers, the consumption rate would have to be more than 14 times lower than the 292 mg/day used in this risk assessment (less than 20 mg/day) in order for RQ values to be below the proposed LOC of 0.4.

Variability in Residue Concentrations. One source of uncertainty in the Tier 1 risk assessment for honey bees relates to the variability in reported sulfoxaflor concentrations in pollen and nectar following foliar applications. Besides the overall high variability is observed in residue concentrations over time, reported concentrations in pollen and nectar do not consistently exhibit an expected proportional increase with pesticide application rate **(Figure 17).** With plant collected pollen, the maximum concentration on Day 0 occurred in the second highest treatment (2 x 0.089 lb a.i./A) while that for Day 5 occurred for the third highest treatment (2 x 0.045 lb a.i./A). In terms of average concentrations of pesticide, similar inconsistencies in proportionally of residues with pesticide application rate are apparent (**Figure 18**). For example, mean residues in plant pollen associated with the highest application rate (2 x 0.134 lb a.i./A) are about one third of corresponding mean residues from the next lower application rate (2 x 0.089 lb a.i./A). The reason for this lack of expected proportionality of pesticide concentrations in pollen is not understood and introduces uncertainty in that reliability of scaling pesticide residues according to application rate.

Conservation of Pesticide Dose. Another uncertainty associated with the Tier 1 risk assessment (particularly for larval bees) is the assumption that storage and processing of pollen and nectar by bees does not reduce pesticide exposure to brood. In the cotton study, residues in pollen collected from the comb were generally lower than that from plants or foragers. However, the maximum overall residue reported was 1.2 ppm from day 5 of the second highest treatment (2 x 0.089 lb ai//A) which is similar to the overall maximum reported in plant pollen (6.6 ppm). This suggests that at least in terms of overall maximum concentrations, the assumption that residues in pollen collected outside the comb are similar to pollen stored inside the comb does not appear to be unreasonably conservative.

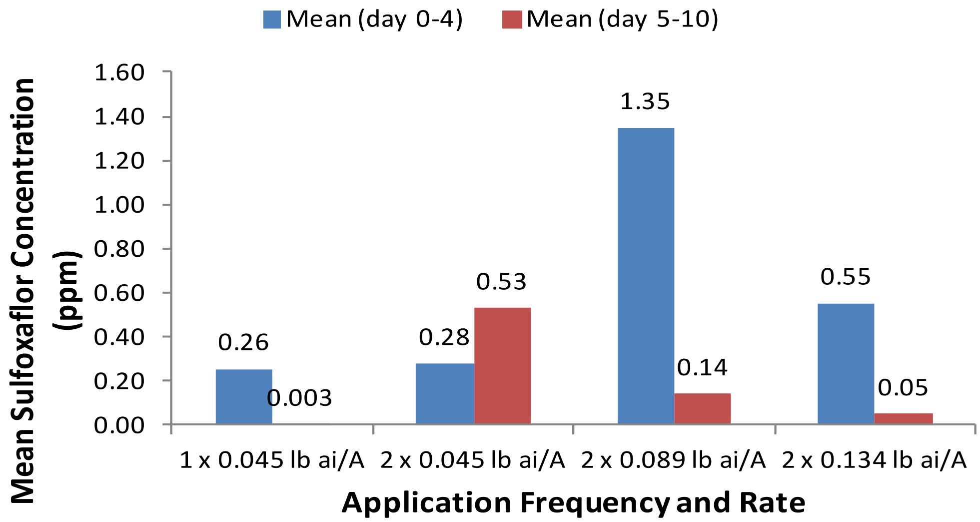

Figure 18. Mean sulfoxaflor residues in plant-collected cotton pollen over different application intervals (MRID 48755606)

b) Tier 2 Risk Assessment

A total of six Tier 2 semi-field (tunnel) studies were submitted by the registrant examining the effects of sulfoxaflor on the honey bee at the colony-level. These studies are relevant to this assessment because results of the Tier 1 risk assessment indicate a potential risk to individual adult and larval honey bees (**Section 5.1.3.5**). As noted previously, there are uncertainties associated with the results of Tier 1 assessment because effects are assessed at the level of the individual bee under controlled laboratory conditions. By quantifying effects at the whole colony level, Tier 2 studies incorporate the combined impact of a chemical stressor (*e.g.*, sulfoxaflor) on honey bee castes and their numerous inter-dependent and potentially compensatory functions within the hive. Furthermore, semi-field exposure of bees to the pesticide is controlled to a significant extent in that bees are forced to forage on treated crop due to confinement in the mesh tunnel. Although semi-field tunnel studies are advantageous in these and other aspects relative to laboratory toxicity studies on individual bees, they also have significant limitations. One limitation includes the relatively short time span that bees can be exposed within the tunnels due to stress associated with confinement (generally no more than 7-14 days). The adequacy of the forage base (nectar, pollen) is considered suboptimal compared to the diverse array of pollen and nectar sources available in natural settings where bees can forage freely. Despite these limitations, semi-field tunnel studies are considered an important line of evidence for evaluating the effects of pesticides on bees at the whole colony level.

The salient features and primary risk conclusions associated with each of the six semi-field studies are summarized in **(Table 47).** A discussion of measured effects of sulfoxaflor on various individual and colony-level endpoints is provided below. Additional details of each study are provided in **Appendix D**.

Study Design Summary. All six tunnel studies differed substantially in their overall design. For example, Hecht-Rost (2009) used a regression-type design which included five different application rates ranging from 0.006 to 0.088 lb ai/A with one replicate (tunnel) per treatment. Similarly, Ythier (2012) evaluated four different application rates ranging from 0.045 to 0.134 lb ai/A) with one replicate tunnel per treatment. The studies by Schmitzer (2010; 2011a,b,c) used a hypothesis-based test design with fewer treatments but three replicate tunnels per treatment with application rates ranging from 0.004 to 0.043 lb a.i./A. Although this design permitted statistical analysis via hypothesis testing, the high variability in response endpoints combined with the small number of replicates (3) resulted in low statistical power for detecting potential treatment-related effects in the vast majority of comparisons. Therefore, observed differences in mean responses across treatments are also emphasized in addition to statistical differences to determine whether any trends were apparent across treatments/controls.

Regarding the timing of pesticide applications, Schmitzer (2010) evaluated sulfoxaflor applications during and after bee flight, while Schmitzer (2011a,b) evaluated applications prior to bloom in addition to during and after bee flight. Schmitzer (2011c), Ythier (2012), and Hecht-Rost (2009) evaluated applications only during bee flight.

The duration of the observation period post-application also differed widely across studies. Hecht-Rost (2009) and Schmitzer (2010) included no observations after hives were removed from the exposure tunnels. Schmitzer (2011a,b,c) included a 10-d, 17-d and 90-d post tunnel (post-exposure) observation period, respectively. Ythier (2012) evaluated effects after 7 days post exposure.

It is also important to note that the time of year when each study was initiated also differed among the studies. Tests were started in June (for Schmitzer 2011a), July (for Schmitzer 2011b), August (for Hecht-Rost 2009, Schmitzer 2010, and Ythier 2012) and October (for Schmitzer 2011c). Since honey bee colonies typically show strong seasonal increases and declines over the course of spring, summer and fall, the timing of the study can be an important factor to consider when interpreting the results.

Lastly, in terms of the relevance of the foliar applications to the proposed registration of sulfoxaflor in the US, it is noted that all but the Ythier (2012) study used application rates that were substantially below the maximum proposed application rate in the US (*i.e.*, below single rate of 0.133 lb ai/A and the yearly maximum rate of 0.266 lb ai/A).

Forager Mortality. Five of the semi-field studies summarized in **Table 47** and **Appendix D** included measures of forager bee mortality determined from observations of dead bees collected away the hive and from dead bee traps at the hive entrances during the period of confinement in the tunnels. In general, the mortality pattern of adult forager bees was similar across the five tunnel studies. A spike in mortality up to 20 times that of control hives was observed on the day of pesticide application (0 day after application; 0DAA). Subsequent to 0DAA, forager bee mortality declined sharply and recovered to levels similar to control hives within 3 days, sometimes less. For studies that included identical application rates during and after bee flight (Schmitzer 2010; 2011a,b), the magnitude of forager bee mortality was generally greater when pesticide was applied during bee flight compared to after bee flight, likely reflecting the combined effect of exposure via direct contact and via contact and/or ingestion residues on plants. The lack of sustained mortality of adult foragers following pesticide applications at rates from 3-67% of the maximum single rate proposed in the US suggests that the direct effects of sulfoxaflor on foraging bees (*i.e*., those effects resulting from exposure from direct contact with spray droplets and residues on plants) are relatively short-lived. However, the potential for indirect effects of short-term loss of foragers on brood development and colony strength over the longer-term (e.g., through pre-mature recruitment of hive bees into the forager work force) at maximum US application rates has not been quantified. Although Ythier (2012) used the maximum single and seasonal application rates, they did not quantify the effects of sulfoxaflor on forager bee mortality since this study was intended to measure sulfoxaflor residues in plant tissues, not biological effects.

In the context of toxicity from dried residues on plants, the lack of sustained mortality to forager bees from residues applied after bee flight is consistent with the results from the foliar residue toxicity study (MRID-47832512) which showed ≤15% mortality after exposure to aged foliar residues from 4 hr to 24 hours.

Forager Flight Activity. The effect of sulfoxaflor on forager bee flight activity generally reduced the activity immediately following pesticide application. Hecht-Rost (2009), Schmitzer (2010) and Schmitzer (2011a, b) all reported reductions in flight activity up to 5 times lower than controls on 0DAA. By 3DAA, however, flight activity was similar to control levels in these studies. No obvious treatment-related effects on flight activity were reported by Schmitzer (2011c); however, the application rates used were very low relative to the proposed maximum US rate (3-16% of the maximum proposed rate). Overall, these results suggest that at rates from 3-67% of the maximum single rate proposed in the US, the direct effects of sulfoxaflor on flight activity of foraging bees (*i.e*., those effects resulting from exposure from direct contact with spray droplets and residues on plants) are relatively short-lived. The effects of sulfoxaflor on the flight activity of foraging bees at maximum application rates proposed in the US have not been quantified.

Behavior Abnormalities. Similar to adult forager mortality and flight activity, the occurrence of behavior abnormalities (*e.g.* uncoordinated movement, spasms or an intensive cleaning behavior) was short-lived at the studied application rates (3-67% of US maximum). The frequency of these behavioral abnormalities was relatively low and they were not sustained beyond 2 days after pesticide application.

Brood Development. The suitability of the submitted semi-field studies for quantifying the effects of sulfoxaflor on developing honey bee brood is very limited, even when they are considered apart from limitations associated with the use of low application rates. Hecht-Rost (2009) and Schmitzer (2010) evaluated brood after only 7 and 9 days exposure, which is far short of the recommended duration of semi-field studies by OECD Guideline 75. A longer post-exposure evaluation time is necessary in order to evaluate the effects over an entire honey bee brood cycle (21 days for workers). Furthermore, these two studies also held bees in tunnels for much longer than recommended prior to exposure (8-11 days vs. 2-3 days recommended by

OECD Guideline 75), which may have confounded interpretation of brood development results as colony bees may have experienced undue stress from prolonged confinement of hives in the tunnel. Schmitzer (2011c) included a long post-exposure observation period (3 months); however, the study was initiated in late October and brood development and colony-strength were already in a state of significant decline due to the late season in which the study was conducted. This uncertainty is supported by the lack of discernible effects on brood at 14DAA by either reference toxicant (dimethoate or fenoxycarb) used in the study. Ythier (2012) evaluated brood pattern at 10DAA and 17DAA (close to an entire brood cycle), but did not include a control treatment in order to make appropriate comparisons. It is noted, however, that this study was not designed to provide a comprehensive evaluation of biological effects; rather it was designed to quantify sulfoxaflor residues in various plant matrices. Although pre- and post-application assessments of brood can be compared (**Table 47**), it is not possible to distinguish the effects of tunnel confinement from those of sulfoxaflor on brood development based on pre- and post-exposure comparisons alone. Adverse effects resulting from tunnel confinement in the cotton study by Ythier (2012) is considered possible (if not likely) because cotton pollen is known to be a sub-optimal source of pollen to honey bees (Vaissiere *et al.*, 1994) and bees were not able to maintain sufficient pollen stores over the course of the tunnel exposure.

Apart from their low applications rates (16-32% of the proposed US maximum), the two studies with the most suitable design for evaluating the effects of sulfoxaflor on honey bee brood are Schmitzer (2011a,b). Both studies included adequate post-application observation periods (20-53 days), used three replicates/treatment, and tracked the development of a defined cohort of marked brood over time (rather than overall brood pattern on the comb). By following the development of individual brood, two indices of brood development were derived (*i.e.*, brood termination index and brood compensation index) according to OECD Guideline 75. The brood termination index is simply the proportion of brood that fails to develop fully through emergence. The brood compensation index is a reflection of the average of the five development stages achieved by the brood cohort (with 1 = egg, 2 = young larvae, 3 = old larvae, 4 = pupae, 5= empty cell [emerged] or cell re-filled with egg/larva).

In both studies, Schmitzer (2011a,b) reported a high average brood termination rate in control hives of 56% and 65%, respectively. This means that over half the brood in control hives failed to emerge and transition to adult bees. Although no specific acceptability criteria have been defined by OECD for this index in controls, these values exceed brood termination rates of controls reported by an inter-laboratory study supporting the development of OECD Guideline 75 (Schur *et al.*, 2003). Notably, Schur *et al.* reported that brood termination rate in control hives varied from 8% to 43% in a ring-test of five trials of the OECD 75 tunnel study design. The authors attributed the high brood termination rates (32-43%) in three trials to poor weather conditions that occurred during the studies. In a recent review of historical control data for brood termination rate, Pistorius *et al*., (2011) correlated increases in control brood termination rate with lateness in the season of test initiation and smaller available forage area in the tunnels. Regardless of the source of the high brood termination rate in the control treatments from Schmitzer (2011a,b), it likely reflects stress on the bees caused by the study design and creates substantial uncertainty as to the ability to detect the potential effects of sulfoxaflor on developing brood. A large increase in brood termination rate (98-100%) was observed for the reference toxicant (fenoxycarb) for these two studies, which indicates that despite the high larval mortality in control hives, a major catastrophic impact on brood could be detected. Importantly, the application rates of fenoxycarb (300 g ai/ha or about 2X the maximum single application rate identified in the US) are specifically intended to cause catastrophic impacts on developing brood in order to demonstrate that the study design was sufficient to detect effects on brood. Although the effects of sulfoxaflor applications on brood development are uncertain due to high mortality of larvae in controls, these results suggest that the overall effects were less than the catastrophic losses experienced by the colonies exposed to the reference toxicant.

The results from the brood compensation index indicated no obvious or statistical differences in treatments compared to controls by 22DAA and 21DAA for Schmitzer (2011a,b), respectively. The average brood compensation rate in control and sulfoxaflor-treated hives ranged from 3.0 to 4.2. This indicates that on average, honey bee broods were able to reach an older larval or pupal stage. Therefore, these results suggest that the high brood termination rate discussed previously occurred principally at the latter stages of brood development. Since the brood compensation and termination indices are related, the uncertainty associated with high brood termination rate in controls also impacts the interpretation of the brood compensation index responses. In both studies, a large reduction in brood compensation index (1.7-1.9) indicates the effects of the reference toxicant (fenoxycarb) were discernible in this study.

Taken as a whole and in consideration of their respective limitations, the results from the six tunnel studies are unable to conclusively demonstrate whether sulfoxaflor applications adversely impact brood development, even at the lower application rates used.

Colony Strength. Measures of colony strength (number of bees occupying the combs) were available from 5 of the 6 tunnel studies submitted (**Table 47**). Assessment relative to concurrent control hives was possible in 3 studies (one study had no concurrent control and the other had compromised controls). In general, effects of sulfoxaflor on colony strength were slight or not apparent with the three studies with controls (Schmitzer 2011a,b,c). A 15-28% reduction in mean colony strength was apparent through most of the exposure period for the treatment with the two highest application rates (0.043 lb ai/A pre-bloom and after flight). However, a similar study conducted by the same authors (Schmitzer 2011b) found no obvious difference in colony strength with 0.043 lb ai/A applied pre-bloom. Similarly, Schmitzer (2011c) found no obvious difference in colony strength of treatments compared to controls by 14DAA. However, it should be noted that application rates used in this study were very low (3-16% of US maximum) and it was conducted late in the season as colonies were in a natural state of decline in terms of brood production.

When colony strength is evaluated by comparing pre- and post-application measurements within a sulfoxaflor treatment, no treatment-related difference is apparent in the study by Hecht-Rost (2009) measured at 7DAA or Ythier (2012) measured at 10 days after first application (10DAFA and 17DAFA. The similarity in colony strength measurements taken pre- and post application within and among all treatments reported for the cotton study (Ythier 2012) implies that conditions of the sulfoxaflor treatments did not result in an obvious decline in mean colony strength by 17DAFA, even at the maximum US application rate of 2 x 0.134 lb ai/A. Although lack of a current control and limited observation period precludes definitive conclusions regarding the effect of sulfoxaflor on colony strength in this study, these results suggest that major impacts on honey bee colony strength are not apparent with sulfoxaflor applications at the maximum US application rate, at least over the short term (*e.g.*, 17DAFA).

Overall Conclusions from Tier 2 Assessment. Results from the Tier 2 semi-field studies suggest that at the application rates used (3-67% of US maximum), the direct effects of sulfoxaflor on adult forager bee mortality, flight activity and the occurrence of behavioral abnormalities is relatively short-lived, lasting 3 days or less. Direct effects are considered those that result directly from interception of spray droplets or dermal contact with and ingestion of foliar residues. The direct effect of sulfoxaflor on these measures at the maximum application rate in the US is presently not known. The effect of sulfoxaflor on brood development is considered inconclusive due to the aforementioned limitations associated with these studies. When compared to controls, the effect of sulfoxaflor on colony strength applied at 3-32% of the US maximum proposed rate was either not apparent or modest at most (based on one study). Sulfoxaflor applied to cotton foliage up to the maximum rate proposed in the US did not result in an observable decline in mean colony strength by 17DAFA when compared to colonies assessed 3 days prior to application. Additional data would be needed to determine the potential effects of sulfoxaflor applications on brood development and long-term colony health at the maximum application rates proposed in the US. Such data would include one or more Tier 2 semi-field tunnel studies conducted according to OECD 75 guidance. It is further noted that the high variability in sulfoxaflor residues from the cotton residue study and the nature of the cotton flowering introduces uncertainty in the extrapolation of these residue results to other crops. Therefore, additional data on the nature and magnitude of sulfoxaflor residues in one or more pollinator-attractive crops would be needed to address this source of uncertainty.

Table 47. Summary of Tier 2 colony-level studies conducted with sulfoxaflor

Study Attribute	Results Summary					
	1. Hecht-Rost (2009) MRID-48445806	**2. Schmitzer (2010)** MRID 48445807	**3. Schmitzer (2011a)** MRID 48755604	**4. Schmitzer (2011b)** MRID 48755605	**5. Schmitzer (2011c)** **(no MRID)**	**6. Ythier 2012** MRID 48755606
Application Timing & Rate	**During flight: 0.006-0.088 lb ai/A** (6-99 g ai/ha)	**During flight: 0.021-0.043 lb ai/A** (24 & 48 g ai/ha) **After flight:** 0.043 lb ai/A (48 g ai/ha)	**Pre bloom: 0.043 lb ai/A** (48 g ai/ha) **After flight: 0.021-0.043 lb ai/A** (24 & 48 g ai/ha) **During flight: 0.021 lb ai/A** (24 g ai/ha)	**Pre bloom: 0.043 lb ai/A** (48 g ai/ha) **After flight: 0.021 lb ai/A** (24 g ai/ha) **During flight: 0.021 lb ai/A** (24 g ai/ha)	**During flight: 0.004, 0.007, 0.021 lb ai/A** (4, 8, 24 g ai/ha)	**During flight**: **0.045 lb ai/A x 1** (50 g ai/ha x 1) **0.045 lb ai/A x 2** (50 g ai/ha x 2) **0.089 lb ai/A x 2** (100 g ai/ha x 2) **0.134 lb ai/A x 2** (150 g ai/ha x 2)
No. Reps. / Treatment	1	3	3	3	3	1
% of US Max. Single Appl. Rate	4-67%	16-32%	16-32%	16-32%	3-16%	34-100%
Crop	*Phacelia*	*Phacelia*	*Phacelia*	*Phacelia*	*Phacelia*	Cotton
Exposure Pathways Assessed	Direct contact, dermal, oral	Direct contact, dermal, oral	**During flight:** Direct contact, dermal, oral **Pre-bloom, after flight:** dermal, oral	**During flight:** Direct contact, dermal, oral **Pre-bloom, after flight:** dermal, oral	Direct contact, dermal, oral	Direct contact, dermal, oral

Study Attribute	Results Summary					
	1. Hecht-Rost (2009) MRID-48445806	**2. Schmitzer (2010)** MRID 48445807	**3. Schmitzer (2011a)** MRID 48755604	**4. Schmitzer (2011b)** MRID 48755605	**5. Schmitzer (2011c)** **(no MRID)**	**6. Ythier 2012** MRID 48755606
Exposure Duration, Month of Study Initiation	**In-Tunnel Exposure**: (pre-application) **11d** (post-application) **7d** **Post Tunnel Obs.:** **0d** August	**In-Tunnel Exposure**: (pre-application) **8d** (post-application) **9d** **Post Tunnel Obs.**: **0d** August	**In-Tunnel Exposure**: (pre-application, after & during flight) **3d** (pre-application, pre-bloom) **0d** (post-application, after & during flight) **7d** (post-application, pre-bloom) **10d** **Post Tunnel Obs.**: **20d** June	**In-Tunnel Exposure**: (pre-application, after & during flight) **10d** (pre-application, pre-bloom) **0d** (post-application, after & during flight) **7d** (post-application, pre-bloom) **17d** **Post Tunnel Obs.**: **53d** July	**In-Tunnel Exposure**: (pre-application) **8d** (post-application) **7d** **Post Tunnel Obs.**: **90d (colony survival)** October	**In-Tunnel Exposure**: (pre-application) 3**d** (post-application) **10d** **Post Tunnel Obs.:** **7d** August-September
Forager Mortality	**Day 0**: up to 7X increase (treatment dependent) **Day 3-7**: ≈ control levels;	**Day 0**: Up to 20X increase **Day 3-7**: ≈ control levels	**Day 0-1**: up to 8X increase in mortality **Days 2-7**: treat ≈ controls **Days 8-27 (post tunnel):** treat ≈ controls	**Day 0**: up to 3X ↑ **Days1-7**: no consistent difference vs. controls**	**Day 0:** up to 4X ↑; **Day 1-7:** treatments ≈ controls	Not assessed
Flight Intensity	**Day 0**: up to 5X decrease (dose-dependent) **Day 3-7**: Dose-independent decrease	**Day 0**: up to 2X decrease **Days 1-7**: treatment ≈ controls	Some reduction seen (during and after bee flight), but recovery to control levels by D2-4	**Day 0:** some (<50%) reduction vs. controls **Day 1-7:** treatment ≈ controls	No obvious treatment related effects on foraging activity, but late season may have confounded results	Not assessed
Forager Behavior	Light intoxication symptoms (D0AA only**)**	Some behavioral abnormalities ≤ 2DAA	Some behavior abnormalities observed on 0DAA in 1 treatment, none thereafter	No behavioral abnormalities observed at any treatment	Some behavior abnormalities observed on 0DAA in 24 g ai/ha, none thereafter	Not assessed

Study Attribute	Results Summary					
	1. Hecht-Rost (2009) MRID-48445806	**2. Schmitzer (2010)** MRID 48445807	**3. Schmitzer (2011a)** MRID 48755604	**4. Schmitzer (2011b)** MRID 48755605	**5. Schmitzer (2011c) (no MRID)**	**6. Ythier 2012** MRID 48755606
Brood Development	**Treat vs. Control:** Inconclusive **Pre vs. Post Appl.:** - Dose-dependent ↓in % Larvae - Dose-independ. ↓ in % capped brood	**Treat vs. Control:** - no statistical or obvious difference @ 9DAA; **Pre vs. Post:** - no statistical or obvious differences; - modest ↓% capped and ↑ % empty cells may reflect emergence	**Treat vs. Control:** **Brood compensation index:** - no statistical or obvious treatment related effects @ 22DAA - **Brood termination rate:** - inconclusive	**Treat vs. Control:** **Brood compensation index:** - no statistical or obvious treatment related effects @ 21DAA - **Brood termination rate:** - inconclusive	**Treat vs. Control:** **Brood pattern:** treat ≈ controls through 14DAA, but late season may have confounded results	No control was included **Pre vs. Post Appl.** **Brood pattern:** - %larvae, %pupae, reduced ~ 2X @ 10DAA; - % pollen ~ 0% @ 10DAA - %nectar ≥ pre-appl. levels - % adult bees within 20% of pre-appl levels
Colony Strength	**Treat vs. Control:** Inconclusive **Pre vs. Post Appl.:** 10-25% dose-independent ↓	Not assessed	**Treat vs. Control:** Up to 15-28% reduction in 48g ai/ha through 27DAA (pre bloom) and 15DAA (after flight)	**Treat vs. Control:** - treatments ≈ controls up through 60DAA	**Treat vs. Control:** - treatments ≥ controls, but late season may have confounded results - By D90AA, only 1/18 colonies failed (8 g/ha)	**Pre vs. Post Appl.** Hive strength similar across treatments before and after application
Study Limitations*	1. *Varroa* infestation in controls 2. Long pre-exposure period in tunnels (11d) 3. High variability among colonies prior to exposure 4. Short observation period (7d) 5. 1 rep/treatment 6. Low % larvae in controls (7DAA)	1. Long pre-exposure period in tunnels (8d) 2. Short observation period (9d) 3. High overall variability within treatments (n=3) 4. No colony strength measurements	1. Poor control performance re: brood termination rate (56%) 2. High overall variability within treatments (n=3)	1. Poor control performance re: brood termination rate (65%) 2. Long pre-exposure period in tunnels (10d) 3. high overall variability within treatments (n=3)	1. All colonies in steep decline in brood condition due to late season (Oct). rendering the ability to detect treatment effects uncertain	1. No concurrent control was included for interpreting biological effects*** 2. one replicate / treatment 3. short observation period (17d)

Study Attribute	Results Summary					
	1. Hecht-Rost (2009) MRID-48445806	**2. Schmitzer (2010)** MRID 48445807	**3. Schmitzer (2011a)** MRID 48755604	**4. Schmitzer (2011b)** MRID 48755605	**5. Schmitzer (2011c)** **(no MRID)**	**6. Ythier 2012** MRID 48755606
Reference Toxicant Effects	**Dimethoate (400g/ha);** - similar brood pattern as controls (except % larvae) - colony strength similar to treatments; - sustained ↑in # dead bees; -sustained ↓flight intensity	**Dimethoate (600g/ha);** - similar brood pattern as controls - sustained ↑in # dead bees; -sustained ↓flight intensity	**Fenoxycarb (300g /ha)** - **Brood compensation:** sustained ↓ vs. controls over 22DAA - **Brood termination:** major impact (98%) - **colony strength:** generally sustained reduction vs. controls	**Fenoxycarb (300g /ha & Dimethoate 600g/ha:** - c**olony strength:** generally sustained ↓ - **brood compensation:** sustained ↓ - **Brood termination:** major impact (98-100%)	**Dimethoate (600g/ha), Thiamethoxam (50g /ha)**: - Brood pattern: similar to controls through 14DAA	Not assessed
***** Except for Ythier (2012), these limitations are in addition to the use of application rates below the proposed U.S. maximum single rate of 0.133 lb ai/A ** 1 of 3 tunnel replicates at 48 g ai/ha showed increased mortality over days 1-7AA, but it is uncertain if this is treatment related. *** this study was designed to assess residues of sulfoxaflor in plant and hive matrices, not biological effects.						

Overall Bee Risk Assessment Conclusions:

In considering multiple lines of evidence, including results of Tier 1 risk assessment, the mode of action of sulfoxaflor, the nature of its uptake and persistence in plant tissues, and results (and limitations) of the Tier 2 studies, the potential impact of the proposed uses of sulfoxaflor at maximum application rates on developing bee brood and colony strength cannot be precluded.

5.2.4 Review of Incident Data

Incident reports submitted to EPA since approximately 1994 have been tracked by assignment of EIIS (Environmental Incident Information System) in an Incident Data System (IDS). Over the 2012 growing season, a Section 18 emergency use was granted for application of sulfoxaflor to cotton in four states (MS, LA, AR, TN). To date, no incident reports have been received in association with the use of sulfoxaflor. However, due to the nature of ecological incident reporting, absence of incidents cannot be construed with absence of incidents.

5.2.5 Endocrine Effects

Under the Federal Food, Drug and Cosmetic Act (FFDCA), as amended by the Food Quality Protection Act (FQPA), EPA is required to develop a screening program to determine whether certain substances (including all pesticide active and other ingredients) "may have an effect in humans that is similar to an effect produced by a naturally-occurring estrogen, or other such endocrine effects as the Administrator may designate." Following the recommendations of its Endocrine Disruptor Screening and Testing Advisory Committee (EDSTAC), EPA determined that there was scientific basis for including, as part of the program, the androgen- and thyroid hormone systems, in addition to the estrogen hormone system. EPA also adopted EDSTAC's recommendation that the Program include evaluations of potential effects in wildlife. For pesticide chemicals, EPA will use FIFRA, to the extent that effects in wildlife may help determine whether a substance may have an effect in humans, and the FFDCA authority to require the wildlife evaluations. As the science develops and the resources allow, screening of additional hormone systems may be added to the Endocrine Disruptor Screening Program (EDSP). When the appropriate screening and or testing protocols being considered under the Agency's Endocrine Disruptor Screening Program have been developed, sulfoxaflor may be subjected to additional screening and or testing to better characterize effects related to endocrine disruption.

5.2.6 Threatened and Endangered Species Concerns

For listed species assessment purposes, the action area is considered to be the area affected directly or indirectly by the Federal action and not merely the immediate area involved in the action. At the initial screening-level, the risk assessment considers broadly described taxonomic groups and so conservatively assumes that list species within those broad groups are collocated within the pesticide treatment area. This means that terrestrial plants and wildlife are assumed to be located on or adjacent to the treated site and aquatic organisms are assumed to be located in a surface water body adjacent to the treated site. The assessment also assumes that the listed species are located within an assumed area which has the relatively highest potential exposure to the pesticide, and that exposures are likely to decrease with distance from the treated area.

If the assumptions associated with the screening-level action area result in RQs that are below the listed species LOCs, "no effect," determination conclusion may be made with respect to listed species in that taxa (for direct effects), and no further refinement of the action is necessary. Furthermore, RQs below the listed species LOCs for a given taxonomic group indicate no concern for indirect effects upon listed species that depend upon the taxonomic group as a resource. However, in situations where the screening assumptions lead to RQs in excess of the risk to listed species LOCs for a given taxonomic group, a potential "may affect," conclusion exists and may be associated with direct effects on listed species belonging to that taxonomic group or may extend to indirect effects upon listed species that depend on that taxonomic group as a resource. In such cases, additional information on the biology of the listed species, the locations of these species, and the locations of use sites could be considered along with available information on the fate and transport properties of the pesticide to determine the extent to which screening assumptions regarding an action area apply to a particular listed organism. These subsequent refinement steps could consider how this information would impact the action area for a particular listed organism and may potentially include areas of exposure that are downwind and downstream of the pesticide use site.

In conducting a screen for indirect effects, direct effects LOCs for each taxonomic group are used to make inferences concerning the potential for indirect effects upon listed species that rely upon non-listed organisms in these taxonomic groups as resources critical to their cycle. Pesticide use scenarios resulting in RQs that are below all direct effect listed species LOCs for all taxonomic groups assessed are considered of no concern for risks to listed species either by direct or indirect effects.

For sulfoxaflor, the potential direct effects to listed species should they co-occur with application sites are indicated for mammals (chronic toxicity) and birds (including terrestrial-phased amphibians and reptiles; acute toxicity), non-target terrestrial insects (using honey bee as a surrogate); freshwater benthic insects (chronic toxicity) and saltwater invertebrates (acute toxicity. Risk to listed species LOCs are not exceeded for plants. For the maximum proposed sulfoxaflor application rates, there may be a potential concern for direct effects to the following groups of organisms:

- Birds
- Mammals
- Terrestrial-phase reptiles
- Terrestrial-phase amphibians
- Terrestrial insects
- Aquatic invertebrates

A spatial co-occurrence analysis would be necessary to delineate the action area. However, given the potential widespread use of sulfoxaflor based on the proposed labels, the action area would likely encompass wide portions of the United States.

5.2.7 Description of Assumptions, Limitations, Uncertainties and Data Gaps

5.2.7.1 Exposure for All Taxa

There are a number of areas of uncertainty in the aquatic and terrestrial risk assessments. The toxicity assessment for terrestrial and aquatic plants and animals is limited by the number of species tested in the available toxicity studies. Use of toxicity data on representative species does not provide information on the potential variability in susceptibility among species to acute and chronic exposures.

For each proposed use, the risk assessment is based on the maximum application rate on the proposed label. The frequency at which actual uses approach these maximum scenarios is dependent on the resistance to the pesticide, the timing of applications, and market forces. Exposure and risks could be overestimated if the actual application rates, frequency of application, or number of applications are lower than the input parameters used for the conservative exposure scenario that was modeled

5.2.7.2 Exposure for Aquatic Species

This Tier II risk assessment relies on best available estimates of environmental fate and physicochemical properties, maximum application rate of sulfoxaflor, application frequency and interval. However, several uncertainties and model limitations are noted and should be considered in interpreting the results of this aquatic risk assessment.

- The frequency at which actual sulfoxaflor uses approach the use estimates modeled is dependent on resistance to the insecticide, timing of applications, and market forces. In general, model output values represent the upper-bound estimates of concentrations that might be observed in surface water due to the application of sulfoxaflor, given available data and model limitations.

- Major uncertainties associated with the standard runoff scenario include the physical construct of the watershed and representation of vulnerable aquatic environments for different geographic regions. The physicochemical properties (pH, redox conditions, *etc*.) of the standard farm pond are based on a Georgia farm pond. These properties are likely to be regionally specific because of local hydrogeological conditions. Any alteration in water quality parameters may impact the environmental behavior of a pesticide. The farm pond represents a well mixed, static water body. Because the farm pond is a static water body (no flow through), it does not account for pesticide removal through flow through or water releases. The lack of flow through the farm pond provides an environmental condition for accumulation of persistent pesticides. The assumption of uniform mixing does not account for stratification due to thermoclines (*e.g.*, seasonal stratification in deep water bodies). Additionally, the dimensions of the standard runoff scenario assume a watershed area to water body volume ratio of 10 ha: 20,000m^3. This ratio is recommended to maintain a sustainable constructed pond in the Southeastern United States. The use of higher watershed area to water body volume ratios (as recommended for sustainable ponds in drier regions of the United States) may lead to higher pesticide concentrations when compared to the standard watershed area to water body volume ratio.

- The standard runoff scenario assumes uniform soils and agronomic management practices across the standard 10-hectare field. Soils can vary substantially across even small areas; this variation is not reflected in the model simulations. Additionally, the impact of unique soil characteristics and soil management practices (*e.g.*, tile drainage) are not considered in the standard runoff scenario. The assumption of uniform site and management conditions is not expected to represent some site-specific conditions. Extrapolating the risk conclusions from the standard pond scenario to other aquatic habitats (*e.g.*, marshes, streams, creeks, and shallow rivers, intermittent aquatic areas) may either underestimate or overestimate the potential risks in those habitats.

- For an acute risk assessment, there is only a one-day averaging time for exposure. Use of such a "peak" concentration, with a 1-in-10 year annual return frequency, implies that exposure is sufficient to elicit acute effects comparable to those observed over more protracted exposure periods tested in the laboratory, typically 48 to 96 hours. In the absence of data regarding time-to-toxic event analyses and latent responses to peak exposure, the degree to which risk is overestimated cannot be quantified.

5.2.7.3 Exposure for Terrestrial Species

This risk assessment relies on the best available estimates of environmental fate and physicochemical properties, maximum application rate of sulfoxaflor, maximum number of applications, and the shortest interval between applications. However, several uncertainties and model limitations are noted and should be considered in interpreting the results of this terrestrial risk assessment.

a) Location of Wildlife Species

For screening terrestrial risk assessments, a generic bird or mammal is assumed to consume 100% of its diet as treated seeds from the application site. This assumption may lead to an overestimation of exposure to species that do not occupy the treated field. The actual habitat requirements of any particular terrestrial species are not considered, and it is assumed that species occupy, exclusively and permanently, the treated area being modeled. This assumption leads to a maximum level of exposure in the risk assessment.

b) Routes of Exposure

Dietary Exposure

Screening-level risk assessments for spray applications of pesticides assume that 100% of the diet is relegated to single food types foraged only from treated fields. These assumptions are likely to be conservative for many species and will tend to overestimate potential risks when species are foraging on multiple sources of food (*i.e.*, not just treated seeds). Furthermore, while the assumption of 100% diet from a treated area may be reasonable worst case assumption for acute exposures, this assumption is likely much less applicable to long-term (chronic) exposures modeled as single food types composed entirely of treated seeds. Data on the amount of wildlife diet composed of seeds from treated fields would be needed to reduced this uncertainty.

Dermal Exposure

The screening assessment does not consider dermal exposure of terrestrial organisms to sulfoxaflor. The Agency is actively pursuing modeling techniques to account for dermal exposure via direct application of spray and by incidental contact with contaminated vegetation, soil and water.

Drinking Water Exposure

Drinking water exposure to a pesticide active ingredient may be the result of consumption of surface water or consumption of the pesticide in dew or other water on the surfaces of treated vegetation. For pesticide active ingredients with a potential to dissolve in runoff, puddles on the treated field may contain the chemical. The SIP tool (version 1.0) was used to assess the potential for exposure concerns to birds and mammals via drinking water alone. Sulfoxaflor's solubility in water (1,380 mg/L) and toxicity to avian and mammalian species are inputs for the potential upper-bound drinking water calculations. Because the test of most sensitive avian species (zebra finch) did not produce a definitive LD_{50} value, the lowest concentration tested that resulted in no significant effects was used as an upper-bound estimate of acute toxicity (>80 mg a.i./kg bw) was used as the toxicity endpoint for birds for SIP. For mammals, an LD_{50} of 1000 mg/kg bw was used (rat). Chronic NOAEC/NOAEL toxicity values used for birds and mammals are 200 ppm (mallard) and 6.07 mg/kg bw (rat). Based on this information, sulfoxaflor exposure through drinking water alone has the potential to be a relevant acute or chronic exposure route exposure route of concern for mammals or birds.

c) Incidental Pesticide Releases Associated with Use

This risk assessment is based on the assumption that the entire treatment area is subject to sulfoxaflor application at the rates specified on the label. This translates to an even seeding rate across an entire field. In reality, there is the potential for uneven application of sulfoxaflor through such plausible incidents as changes in calibration of application equipment, spillage, and localized releases at specific areas of the treated field that are associated with specifics of the type of application equipment

d) Residues in Pollen and Nectar

Residue information is available for three plant species: pumpkin, cotton and *Phacelia*. As noted previously, there are limitations in these data which contribute to uncertainty in the Tier 1 risk assessment for bees. Specifically, the pumpkin residue data reflect systemic transport only and were collected several days after pesticide application. The *Phacelia* residue data are from application rate lower than the proposed U.S. maximum and are very limited for pollen and nectar. The cotton study contains the most extensive residue information available, However, the high variability in sulfoxaflor residues from the cotton residue study and the nature of the cotton flowering (*i.e.*, open for only one day) introduces uncertainty in the extrapolation of these residue results to other crops. Therefore, additional data on the nature and magnitude of sulfoxaflor residues in one or more pollinator-attractive crops would be needed to address this source of uncertainty.

5.2.7.4 Effects Assessment for All Taxa

a) Age Class and Sensitivity of Effects Thresholds

It is generally recognized that test organism age may have a significant impact on the observed sensitivity to a toxicant. The screening risk assessment acute toxicity data for fish are collected on juvenile fish and aquatic invertebrate acute testing is performed on recommended immature age classes. Similarly, acute dietary testing with birds is also performed on juveniles, with mallard being 5-10 days old and quail at 10-14 days of age.

Testing of juveniles may overestimate the toxicity of direct acting pesticides in adults. As juvenile organisms do not have fully developed metabolic systems, they may not possess the ability to transform and detoxify xenobiotics equivalent to the older/adult organism. The screening risk assessment has no current provisions for a generally applied method that accounts for this uncertainty. In so far as the available toxicity data may provide ranges of sensitivity information with respect to age class, the risk assessment uses the most sensitive life-stage information as the conservative screening endpoint.

b) Lack of Effects Data for Amphibians and Reptiles

Currently, toxicity studies on amphibians and reptiles are not required for pesticide registration. Since these data are lacking, the Agency uses fish as surrogates for aquatic-phase amphibians and birds as surrogates for terrestrial-phase amphibians and reptiles. If other species are more or less sensitive to sulfoxaflor than the surrogates, risks may be under- or overestimated, respectively. The Agency is not limited to a base set of surrogate toxicity information in establishing risk assessment conclusions. The Agency also considers toxicity data on non-standard test species when available. Further research is needed to determine whether, in general, reptiles and terrestrial-phase amphibians are suitably represented by bird species in assessing risks for sulfoxaflor and fish are an appropriate surrogate for aquatic-phase amphibians.

c) Use of the Most Sensitive Species Tested

Although the screening-level risk assessment relies on a selected toxicity endpoint from the most sensitive species tested, it does not necessarily mean that the selected toxicity endpoints reflect sensitivity of the most sensitive species existing in a given environment. The relative position of the most sensitive species tested in the distribution of all possible species is a function of the overall variability among species to a particular chemical. The relationship between the sensitivity of the most sensitive tested species versus wild species (including listed species) is unknown and a source of significant uncertainty. In addition, in the case of listed species, there is uncertainty regarding the relationship of the listed species' sensitivity and the most sensitive species tested.

d) Brood Development and Colony-Level Effects

As described in **Section 5.2.3.3**, the results from the available semi-field tunnel studies are insufficient for concluding whether sulfoxaflor applications adversely impact brood development, even at the lower application rates used. Additional data would be needed to determine the potential effects of sulfoxaflor applications on brood development and long-term colony health at the maximum application rates proposed in the US. Such data would include one or more Tier 2 semi-field tunnel studies conducted according to OECD 75 guidance.

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Dow AgroSciences

Dow AgroSciences LLC 9330 Zionsville Road Indianapolis, IN 46268-1054 USA

Closer® SC

EPA Reg. No. 62719-623

For Control of Asian Citrus Psyllid in Citrus
Section 18 Emergency Exemption

File symbol: XXXXXX

FOR DISTRIBUTION AND USE ONLY IN XXXX UNDER SECTION 18 EMERGENCY EXEMPTION
This Section 18 Emergency Exemption is effective XXXXX and expires XXXXXXX.

- This labeling must be in the possession of the user at the time of application.
- It is in violation of federal law to use this product in a manner inconsistent with its labeling.
- All application directions, restrictions, and precautions on the registered product label for Closer SC (EPA Reg. No. 62719-623) are to be followed.
- Any adverse effects resulting from the use of Closer SC under this emergency exemption must be immediately reported to the Texas Department of Agriculture.

Directions for Use

Pests and Application Rates:

Pests	Closer SC (fl oz/acre)
Asian citrus psyllid	2.75 – 5.75 (0.043 – 0.09 lb ai/acre)

Advisory Pollinator Statement: Notifying known beekeepers within 1 mile of the treatment area 48 hours before the product is applied will allow them to take additional steps to protect their bees. Also, limiting application to times when managed bees and native pollinators are least active, e.g., before 7 am or after 7 pm local time or when the temperature is below 55ºF at the site of application, will minimize risk to bees.

Application Timing: Treat in accordance with local economic thresholds. Consult your Dow AgroSciences representative, cooperative extension service, certified crop advisor or state agricultural experiment station for any additional local use recommendations for your area. Time application for scales to the crawler stage.

Application Rate: Use a higher rate in the rate range for heavy pest populations.

Restrictions:
- **Preharvest Interval:** Do not apply within 1 day of harvest.
- **Minimum Treatment Interval:** Do not make applications less than 14 days apart.
- Do not make more than four applications per crop.
- Do not make more than two consecutive applications per crop.
- Do not apply more than a total of 17 fl oz of Closer SC (0.266 lb ai of sulfoxaflor) per acre per year.
- Only one application is allowed between 3 days before bloom and until after petal fall per year.

Environmental Hazards

This product is highly toxic to bees exposed through contact during spraying and while spray droplets are still wet. This product may be toxic to bees exposed to treated foliage for up to 3 hours following application. Toxicity is reduced when spray droplets are dry.

Risk to managed bees and native pollinators from contact with pesticide spray or residues can be minimized when applications are made before 7:00 am or after 7:00 pm local time or when the temperature is below 55 degrees F at the site of application.

Do not apply directly to water, to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters.

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R391-016
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Initial Printing.

Specimen Label

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Closer® SC

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ISOCLAST™ ACTIVE

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For control or suppression of aphids, fleahoppers, plant bugs, stink bugs, whiteflies and certain psyllids, scales, and thrips in *Brassica* (cole) leafy vegetables, citrus, cotton, cucurbit vegetables, fruiting vegetables, leafy vegetables (except *Brassica*), leaves of root and tuber vegetables, low growing berry, okra, pistachio, pome fruits, small fruit vine climbing (except fuzzy kiwifruit) except strawberry, strawberry, stone fruits, tree nuts, watercress.

Group	4C	INSECTICIDE

Active Ingredient:
sulfoxaflor 21.8%
Other Ingredients 78.2%
Total 100.0%

Contains 2 lb active ingredient per gallon.

Precautionary Statements

Hazard to Humans and Domestic Animals

EPA Reg. No. 62719-623

CAUTION

Causes Moderate Eye Irritation

Avoid contact with eyes or clothing.

Personal Protective Equipment (PPE)

Applicators and other handlers must wear:
- Long-sleeved shirt and long pants
- Shoes plus socks

Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

User Safety Recommendations

Users should:
- Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.
- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.

First Aid

If in eyes: Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-992-5994 for emergency medical treatment information.

Environmental Hazards

This product is highly toxic to bees exposed through contact during spraying and while spray droplets are still wet. This product may be toxic to bees exposed to treated foliage for up to 3 hours following application. Toxicity is reduced when spray droplets are dry.

Risk to managed bees and native pollinators from contact with pesticide spray or residues can be minimized when applications are made before 7:00 am or after 7:00 pm local time or when the temperature is below 55° F at the site of application.

Refer to the Directions for Use for crop specific restrictions and additional advisory statements to protect pollinators.

Do not apply directly to water, to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters.

Directions for Use

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.
Read all Directions for Use carefully before applying.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your state or tribe, consult the agency responsible for pesticide regulation.

Agricultural Use Requirements

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR Part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE), and restricted entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 12 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is:
- Coveralls
- Shoes plus socks

Non-Agricultural Use Requirements

The requirements in this box apply to uses of this product that are NOT within the scope of the Worker Protection Standard for agricultural pesticides (40 CFR Part 170). The WPS applies when this product is used to produce agricultural plants on farms, forests, nurseries, or greenhouses.

Do not enter or allow others to enter the treated area until sprays have dried.

Storage and Disposal

Do not contaminate water, food or feed by storage or disposal.
Pesticide Storage: Store in original container only.
Pesticide Disposal: Wastes resulting from the use of this product must be disposed of on site or at an approved waste disposal facility.

Nonrefillable rigid containers 5 gallons or less:
Container Handling: Nonrefillable container. Do not reuse or refill this container.
Triple rinse or pressure rinse container (or equivalent) promptly after emptying. **Triple rinse** as follows: Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container 1/4 full with water and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times. **Pressure rinse** as follows: Empty the remaining contents into application equipment or a mix tank and continue to drain for 10 seconds after the flow begins to drip. Hold container upside down over application equipment or mix tank or collect rinsate for later use or disposal. Insert pressure rinsing nozzle in the side of the container, and rinse at about 40 psi for at least 30 seconds. Drain for 10 seconds after the flow begins to drip. Then offer for recycling if available or puncture and dispose of in a sanitary landfill, or by incineration, or by other procedures allowed by state and local authorities.

Refillable rigid containers larger than 5 gal:
Container Handling: Refillable container. Refill this container with pesticide only. Do not reuse this container for any other purpose.

Storage and Disposal (Cont.)

Cleaning the container before final disposal is the responsibility of the person disposing of the container. Cleaning before refilling is the responsibility of the refiller. To clean the container before final disposal, empty the remaining contents from this container into application equipment or a mix tank. Fill the container about 10% full with water and, if possible, spray all sides while adding water. If practical, agitate vigorously or recirculate water with the pump for two minutes. Pour or pump rinsate into application equipment or rinsate collection system. Repeat this rinsing procedure two more times. Then offer for recycling if available, or puncture and dispose of in a sanitary landfill, or by incineration, or by other procedures allowed by state and local authorities.

Nonrefillable rigid containers larger than 5 gal:
Container Handling: Nonrefillable container. Do not reuse or refill this container.
Triple rinse or pressure rinse container (or equivalent) promptly after emptying. **Triple rinse** as follows: Empty the remaining contents into application equipment or a mix tank. Fill the container 1/4 full with water. Replace and tighten closures. Tip container on its side and roll it back and forth, ensuring at least one complete revolution, for 30 seconds. Stand the container on its end and tip it back and forth several times. Turn the container over onto its other end and tip it back and forth several times. Empty the rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Repeat this procedure two more times. **Pressure rinse** as follows: Empty the remaining contents into application equipment or a mix tank and continue to drain for 10 seconds after the flow begins to drip. Hold container upside down over application equipment or mix tank or collect rinsate for later use or disposal. Insert pressure rinsing nozzle in the side of the container, and rinse at about 40 psi for at least 30 seconds. Drain for 10 seconds after the flow begins to drip. Then offer for recycling if available, or puncture and dispose of in a sanitary landfill, or by incineration, or by other procedures allowed by state and local authorities.

Product Information

Carefully read, understand and follow label use rates and restrictions. Apply the amount specified in the following tables with properly calibrated aerial or ground spray equipment. Prepare only the amount of spray solution required to treat the measured acreage. The low rates may be used for light infestations of the target pests and the higher rates for moderate to heavy infestations. Closer SC insecticide may be applied in either dilute or concentrate sprays so long as the application equipment is calibrated and adjusted to deliver thorough, uniform coverage. Use the specified amount of Closer SC per acre regardless of the spray volume used.

Use Precautions

Integrated Pest Management (IPM) Programs
Closer SC is recommended for IPM programs in labeled crops. Apply Closer SC when field scouting indicates target pest densities have reached the economic threshold, i.e., the point at which the insect population must be reduced to avoid economic losses beyond the cost of control. Other than reducing the target pest species as a food source, Closer SC does not have a significant impact on most parasitic insects or the natural predaceous arthropod complex in treated crops, including big-eyed bugs, ladybird beetles, flower bugs, lacewings, minute pirate bugs, damsel bugs, assassin bugs, predatory mites or spiders. The feeding activities of these beneficials will aid in natural control of other insects and reduce the likelihood of secondary pest outbreaks. If Closer SC is tank mixed with any insecticide that reduces its selectivity in preserving beneficial predatory insects, the full benefit of Closer SC in an IPM program may be reduced.

Insecticide Resistance Management (IRM)
Closer SC contains a Group 4C insecticide. Insect biotypes with acquired resistance to Group 4C insecticides may eventually dominate the insect population if Group 4C insecticides are used repeatedly in the same field or area, or in successive years as the primary method of control for targeted species. This may result in partial or total loss of control of those species by Closer SC or other Group 4C insecticides.

To delay development of insecticide resistance, the following practices are recommended:

- Avoid consecutive use of insecticides on succeeding generations with the same mode of action (same insecticide group) on the same insect species.
- Consider tank mixtures or premix products containing insecticides with different modes of action (different insecticide groups) provided the products are registered for the intended use.
- Base insecticide use upon comprehensive IPM programs.
- Monitor treated insect populations in the field for loss of effectiveness.
- Do not treat seedling plants grown for transplant in greenhouses, shade houses, or field plots.
- Contact your local extension specialist, certified crop advisor, and/or manufacturer for insecticide resistance management and/or IPM recommendations for the specific site and resistant pest problems.
- For further information or to report suspected resistance, you may contact Dow AgroSciences by calling 800-258-3033.

Mixing Directions

Application Rate Reference Table

Application Rate of Closer SC (fl oz/acre)	Active Ingredient Equivalent (lb ai/acre)
0.75	0.012
1.5	0.023
2	0.031
2.75	0.043
3.5	0.061
4.25	0.066
4.5	0.070
5.75	0.09

Closer SC – Alone
Fill the spray tank with water to about 1/2 of the required spray volume. Start agitation and add the required amount of Closer SC. Continue agitation while mixing and filling the spray tank to the required spray volume. Maintain sufficient agitation during application to ensure uniformity of the spray mix. Do not allow water or spray mixture to back-siphon into the water source.

Closer SC - Tank Mix
Closer SC is believed to be compatible with most commonly used agricultural fungicides, insecticides, growth regulators, foliar fertilizers and spray adjuvants. However, whenever preparing a new tank mix, always conduct a compatibility test by mixing proportional amounts of all spray ingredients in a test vessel (jar). Shake the mixture vigorously and allow it to stand for 15 minutes. Rapid precipitation of the ingredients and failure to re-suspend when shaken indicates that the mixture is incompatible and should not be applied.

Mixing Order for Tank Mixes: Fill the spray tank with water to 1/4 to 1/3 of the required spray volume. Start agitation. Add different formulation types in the order indicated below, allowing time for complete dispersion and mixing after addition of each product. Allow extra dispersion and mixing time for dry flowable products.

Add different formulation types in the following order:
1. Water dispersible granules
2. Wettable powders
3. Closer SC and other aqueous suspensions

Maintain agitation and fill spray tank to 3/4 of total spray volume. Then add:
4. Emulsifiable concentrates and water-based solutions
5. Spray adjuvants, surfactants and oils
6. Foliar fertilizers

Finish filling the spray tank. Maintain continuous agitation during mixing, final filling and throughout application. If spraying and agitation must be stopped before the spray tank is empty, the materials may settle to the bottom. Settled materials must be resuspended before spraying is resumed. A sparger agitator is particularly useful for this purpose.

Premixing: Dry and flowable formulations may be premixed with water (slurried) and added to the spray tank through a 20 to 35 mesh screen. This procedure assures good initial dispersion of these formulation types.

Application Directions

Not for Residential Use

Proper application techniques help ensure thorough spray coverage and correct dosage for optimum insect control. Apply Closer SC as a foliar spray at the rate indicated for target pest. The following directions are provided for ground and aerial application of Closer SC. Attention should be given to sprayer speed and calibration, wind speed, and foliar canopy to ensure adequate spray coverage.

Spray Drift Management
Wind: To reduce off-target drift and achieve maximum performance, apply when wind velocity favors on-target product deposition.

Temperature Inversions: Do not make ground or aerial applications during a temperature inversion. Temperature inversions are characterized by stable air and increasing temperatures with height above the ground. Mist or fog may indicate the presence of an inversion in humid areas. The applicator may detect the presence of an inversion by producing smoke and observing a smoke layer near the ground surface.

Droplet Size: Use only medium or coarser spray nozzles (for ground and non-ULV aerial application) according to ASABE (S-572.1) definition for standard nozzles. In conditions of low humidity and high temperatures, applicators should use a coarser droplet size except where indicated for specific crops.

Ground Application

To prevent drift from groundboom applications, apply using a nozzle height of no more than 4 feet above the ground or crop canopy. Shut off the sprayer when turning at row ends. Risk of exposure to sensitive aquatic areas can be reduced by avoiding applications when wind directions are toward the aquatic area.

Airblast Sprayer: When using an airblast sprayer, coverage is also improved by operation of the sprayer at ground speeds that assure that the air volume within the tree canopy is completely replaced by the output from the airblast sprayer. Making applications in an alternate row middle pattern may result in less than satisfactory coverage and poor performance in conditions of high pest infestation levels, extremely large trees and/or dense foliage. For airblast applications, turn off outward pointing nozzles at row ends and when spraying the outer two rows. To minimize spray loss over the top in orchard applications, spray must be directed into the canopy.

Row Crop Application

Use calibrated power-operated ground spray equipment capable of providing uniform coverage of the target crop. Orient the boom and nozzles to obtain uniform crop coverage. Use a minimum of 5 to 10 gallons per acre, increasing volume with crop size and/or pest pressure. Use hollow cone, twin jet flat fan nozzles or other atomizer suitable for insecticide spraying to provide a medium to coarser spray quality (per ASABE S-572.1, see nozzle catalogs). Under certain conditions, drop nozzles may be required to obtain complete coverage of plant surfaces. Follow manufacturer's specifications for ideal nozzle spacing and spray pressure. Minimize boom height to optimize uniformity of coverage and maximize deposition (optimize on-target deposition) to reduce drift.

Orchard/Grove Spraying Application

Dilute Spray Application: This application method is based upon the premise that all plant parts are thoroughly wetted, to the point of runoff, with spray solution. To determine the number of gallons of dilute spray required per acre, contact your state agricultural experiment station, certified pest control advisor, or extension specialist for assistance.

Concentrate Spray Application: This application method is based upon the premise that all the plant parts are uniformly covered with spray solution but not to the point of runoff as with a dilute spray. Instead, a lower spray volume is used to deliver the same application rate per acre as used for the dilute spray.

Aerial Application

Apply in a minimum spray volume of 3 gallons per acre. Mount the spray boom on the aircraft so as to minimize drift caused by wing tip or rotor vortices. Use the minimum practical boom length and do not exceed 75% of the wing span or 80% of the rotor diameter. Flight speed and nozzle orientation must be considered in determining droplet size. Spray must be released at the lowest height consistent with pest control and flight safety. Do not release spray at a height greater than 10 feet above the crop canopy unless a greater height is required for aircraft safety. When applications are made with a crosswind, the swath will be displaced downwind. The applicator must compensate for this displacement at the downwind edge of the application area by adjusting the path of the aircraft upwind.

Spray Adjuvants

The addition of agricultural adjuvants to sprays of Closer SC may improve initial spray deposits, redistribution and weatherability. Select adjuvants that are recommended and registered for your specific use pattern and follow their use directions. When an adjuvant is to be used with this product, Dow AgroSciences recommends the use of a Chemical Producers and Distributors Association certified adjuvant. Always add adjuvants last in the mixing process.

Rotational Crop Restrictions

The following rotational crops may be planted at intervals defined below following the final application of Closer SC at specified rates for a registered use.

Crop	Re-Planting Interval
crops registered use	no restrictions
all other crops grown for food or feed	30 days

Use Directions

Brassica (Cole) Leafy Vegetables (Crop Group 5)[1]

[1]*Brassica* (cole) leafy vegetables (crop group 5) including broccoli, broccoli raab, Brussels sprouts, cabbage, cauliflower, cavalo, Chinese broccoli (gia lon), Chinese cabbage (bok choy), Chinese cabbage (napa), Chinese mustard cabbage (gai choy), collards, kale, kohlrabi, mizuna, mustard greens, mustard spinach, rape greens, white flowering broccoli

Pests and Application Rates:

Pests	Closer SC (fl oz/acre)
aphids	1.5 – 2.0 (0.023 – 0.031 lb ai/acre)
silverleaf whitefly sweetpotato whitefly	4.25 – 5.75 (0.066 – 0.09 lb ai/acre)
thrips (suppression only)	5.75 (0.09 lb ai/acre)

Application Timing: Treat in accordance with local economic thresholds. Consult your Dow AgroSciences representative, cooperative extension service, certified crop advisor or state agricultural experiment station for any additional local use recommendations for your area. Two applications may be required for optimum control of whiteflies.

Application Rate: Use a higher rate in the rate range for heavy pest populations.

Restrictions:

- **Preharvest Interval:** Do not apply within 3 days of harvest.
- **Minimum Treatment Interval:** Do not make applications less than 7 days apart.
- Do not make more than four applications per crop.
- Do not make more than two consecutive applications per crop.
- Do not apply more than a total of 17 fl oz of Closer SC (0.266 lb ai of sulfoxaflor) per acre per year.
- Do not apply this product at any time between 3 days prior to bloom and until after petal fall.

Citrus (Crop Group 10)[1]

[1]Citrus (crop group 10) including citrus citron, grapefruit, kumquat, lemon, lime, orange, tangelo, tangerine, and hybrids of these

Pests and Application Rates:

Pests	Closer SC (fl oz/acre)
aphids	1.5 – 2.75 (0.023 – 0.043 lb ai/acre)
Asian citrus psyllid citrus snow scale mealybugs	2.75 – 5.75 (0.043 – 0.09 lb ai/acre)
Citrus thrips Florida red scale	5.75 (0.09 lb ai/acre)
Suppression only: California red scale citricola scale	5.75 (0.09 lb ai/acre)

Advisory Pollinator Statement: Notifying known beekeepers within 1 mile of the treatment area 48 hours before the product is applied will allow them to take additional steps to protect their bees. Also, limiting application to times when managed bees and native pollinators are least active, e.g., before 7 am or after 7 pm local time or when the temperature is below 55°F at the site of application, will minimize risk to bees.

Application Timing: Treat in accordance with local economic thresholds. Consult your Dow AgroSciences representative, cooperative extension service, certified crop advisor or state agricultural experiment station for any additional local use recommendations for your area. Time application for scales to the crawler stage.

Application Rate: Use a higher rate in the rate range for heavy pest populations.

Restrictions:

- **Preharvest Interval:** Do not apply within 1 day of harvest.
- **Minimum Treatment Interval:** Do not make applications less than 14 days apart.
- Do not make more than four applications per crop.
- Do not make more than two consecutive applications per crop.

- Do not apply more than a total of 17 fl oz of Closer SC (0.266 lb ai of sulfoxaflor) per acre per year.
- Only one application is allowed between 3 days before bloom and until after petal fall per year.

Cucurbit Vegetables (Crop Group 9)[1]

[1]Cucurbit vegetables (crop group 9) including balsam apple, balsam pear, bitter melon, casaba, chayote, Chinese cucumber, Chinese okra, crenshaw melon, crookneck squash, cucumber, cucuzza, edible gourds, golden pershaw melon, hechima, honey balls, honeydew melon, hyotan, mango melon, muskmelons (cantaloupe, honeydew, etc.), Persian melon, pineapple melon, pumpkin, Santa Claus melon, scallop squash, snake melon, spaghetti squash, straightneck squash, summer squash, true cantaloupe, vegetable marrow, watermelon, winter squash, and other varieties and/or hybrids of these

Pests and Application Rates:

Pests	Closer SC (fl oz/acre)
aphids	1.5 – 2.0 (0.023 – 0.031 lb ai/acre)
silverleaf whitefly sweetpotato whitefly thrips (suppression only)	4.25 – 4.5 (0.066 – 0.07 lb ai/acre)

Advisory Pollinator Statement: Notifying known beekeepers within 1 mile of the treatment area 48 hours before the product is applied will allow them to take additional steps to protect their bees. Also, limiting application to times when managed bees and native pollinators are least active, e.g., before 7 am or after 7 pm local time or when the temperature is below 55°F at the site of application, will minimize risk to bees.

Application Timing: Treat in accordance with local economic thresholds. Consult your Dow AgroSciences representative, cooperative extension service, certified crop advisor or state agricultural experiment station for any additional local use recommendations for your area. Two applications may be required for optimum control of whiteflies

Application Rate: Use a higher rate in the rate range for heavy pest populations.

Restrictions:
- **Preharvest Interval:** Do not apply within 1 day of harvest.
- **Minimum Treatment Interval:** Do not make applications less than 7 days apart.
- Do not make more than four applications per crop.
- Do not make more than two consecutive applications per crop.
- Do not apply more than a total of 17 fl oz of Closer SC (0.266 lb ai of sulfoxaflor) per acre per year.

Fruiting Vegetables (Crop Group 8)[1] and Okra

[1]Fruiting vegetables (crop group 8) including bell pepper, eggplant, groundcherry, hot pepper, pepino, pepper (except black), pimento, sweet pepper, tomatillo, tomato

Pests and Application Rates:

Pests	Closer SC (fl oz/acre)
aphids	1.5 – 2.0 (0.023 – 0.031 lb ai/acre)
plant bugs	2.75 – 4.5 (0.043 – 0.07 lb ai/acre)
greenhouse whitefly (outdoors) silverleaf whitefly sweetpotato whitefly thrips (suppression only)	4.25 – 4.5 (0.066 – 0.07 lb ai/acre)

Application Timing: Treat in accordance with local economic thresholds. Consult your Dow AgroSciences representative, cooperative extension service, certified crop advisor or state agricultural experiment station for any additional local use recommendations for your area. Two applications may be required for optimum control of whiteflies.

Application Rate: Use a higher rate in the rate range for heavy pest populations.

Restrictions:
- **Preharvest Interval:** Do not apply within 1 day of harvest.
- **Minimum Treatment Interval:** Do not make applications less than 7 days apart.
- Do not make more than four applications per crop.
- Do not make more than two consecutive applications per crop.
- Do not apply more than a total of 17 fl oz of Closer SC (0.266 lb ai of sulfoxaflor) per acre per year.

Leafy Vegetables (Except *Brassica*) (Crop Group 4)[1] and Watercress

[1]Leafy vegetables (except *Brassica*) (crop group 4) including amaranth, arugula, cardoon, celery, celtuce, chervil, Chinese celery, Chinese spinach, corn salad, cos (romaine), dandelion, dock, edible-leaved chrysanthemum, endive (escarole), finochio, Florence fennel, garden cress, garden purslane, garland chrysanthemum, head lettuce, leaf lettuce, leafy amaranth, New Zealand spinach, orach, parsley, radicchio (red chicory), rhubarb, spinach, sweet anise, sweet fennel, Swiss chard, tampala, upland cress, vine spinach, winter cress, winter purslane, yellow rocket

Pests and Application Rates:

Pests	Closer SC (fl oz/acre)
aphids	1.5 – 2.0 (0.023 – 0.031 lb ai/acre)
silverleaf whitefly sweetpotato whitefly	4.25 – 5.75 (0.066 – 0.09 lb ai/acre)
thrips (suppression only)	5.75 (0.09 lb ai/acre)

Application Timing: Treat in accordance with local economic thresholds. Consult your Dow AgroSciences representative, cooperative extension service, certified crop advisor or state agricultural experiment station for any additional local use recommendations for your area. Two applications may be required for optimum control of whiteflies

Application Rate: Use a higher rate in the rate range for heavy pest populations.

Restrictions:
- **Preharvest Interval:** Do not apply within 3 days of harvest.
- **Minimum Treatment Interval:** Do not make applications less than 7 days apart.
- Do not make more than four applications per crop.
- Do not make more than two consecutive applications per crop.
- Do not apply more than a total of 17 fl oz of Closer SC (0.266 lb ai of sulfoxaflor) per acre per year.
- Do not apply this product at any time between 3 days prior to bloom and until after petal fall.

Leaves of Root and Tuber Vegetables (Crop Group 2)[1]

[1]Leaves of root and tuber vegetables (crop group 2) including bitter cassava, black salsify, broccoli raab, carrot, celeriac (celery root), chicory, dasheen (taro), edible burdock, garden beet, hanover salad, oriental radish (daikon), parsnip, raab, raab salad, radish, rutabaga, sugar beet, sweet cassava, sweet potato, tanier, true yam, turnip, turnip-rooted chervil

Pests and Application Rates:

Pests	Closer SC (fl oz/acre)
aphids	1.5 – 2.0 (0.023 – 0.031 lb ai/acre)
leafhoppers	2.75 – 5.75 (0.043 – 0.09 lb ai/acre)
silverleaf whitefly sweetpotato whitefly	4.25 – 5.75 (0.066 – 0.09 lb ai/acre)

Application Timing: Treat in accordance with local economic thresholds. Consult your Dow AgroSciences representative, cooperative extension service, certified crop advisor or state agricultural experiment station for any additional local use recommendations for your area. Two applications may be required for optimum control of whiteflies.

Application Rate: Use a higher rate in the rate range for heavy pest populations.

Restrictions:
- **Preharvest Interval:** Do not apply within 7 days of harvest.
- **Minimum Treatment Interval:** Do not make applications less than 7 days apart.
- Do not make more than four applications per crop.
- Do not make more than two consecutive applications per crop.

- Do not apply more than a total of 17 fl oz of Closer SC (0.266 lb ai of sulfoxaflor) per acre per year.
- Do not apply this product at any time between 3 days prior to bloom and until after petal fall.

Pome Fruits (Crop Group 11)[1]

[1]Pome fruits (crop group 11) including apples, crabapple, loquat, mayhaw, pears, quince

Pests and Application Rates:

Pests	Closer SC (fl oz/acre)
Aphids (except woolly apple aphid) white apple leafhopper	1.5 – 2.75 (0.023 – 0.043 lb ai/acre)
plant bugs woolly apple aphid	2.75 – 5.75 (0.043 – 0.09 lb ai/acre)
pear psylla (suppression only) San Jose scale (suppression only)	5.75 (0.09 lb ai/acre)

Application Timing: Treat in accordance with local economic thresholds. Consult your Dow AgroSciences representative, cooperative extension service, certified crop advisor or state agricultural experiment station for any additional local use recommendations for your area. Time application for San Jose scale to the crawler stage.

Application Rate: Use a higher rate in the rate range for heavy pest populations.

Restrictions:
- **Preharvest Interval:** Do not apply within 7 days of harvest.
- **Minimum Treatment Interval:** Do not make applications less than 7 days apart.
- Do not make more than four applications per crop.
- Do not make more than two consecutive applications per crop.
- Do not apply more than a total of 17 fl oz of Closer SC (0.266 lb ai of sulfoxaflor) per acre per year.
- Do not apply this product at any time between 3 days prior to bloom and until after petal fall.

Small Fruit Vine Climbing (Except Fuzzy Kiwifruit) (Subgroup 13-07F)[1] and Low Growing Berry (Subgroup 13-07G)[2] except Strawberry

[1]Small fruit vine climbing (except fuzzy kiwifruit) (subgroup 13-07F) including amur river grape, gooseberry, grape, hardy kiwifruit, maypop, schisandra berry, and cultivars, varieties and/or hybrids of these
[2]Low growing berry (subgroup 13-07G) including bearberry, bilberry, lowbush blueberry, cloudberry, cranberry, lingonberry, muntries, partridgeberry, and cultivars, varieties and/or hybrids of these

Pests and Application Rates:

Pests	Closer SC (fl oz/acre)
grape leafhopper mealybugs plant bugs	2.75 – 5.75 (0.043 – 0.09 lb ai/acre)
thrips (suppression)	5.75 (0.09 lb ai/acre)

Application Timing: Treat in accordance with local economic thresholds. Consult your Dow AgroSciences representative, cooperative extension service, certified crop advisor or state agricultural experiment station for any additional local use recommendations for your area.

Application Rate: Use a higher rate in the rate range for heavy pest populations.

Restrictions:
- **Preharvest Interval:** Do not apply within 7 days of harvest of small fruit vine climbing (except fuzzy kiwifruit) and within 1 day of harvest of low growing berry.
- **Minimum Treatment Interval:** Do not make applications less than 7 days apart.
- Do not make more than four applications per crop.
- Do not make more than two consecutive applications per crop.
- Do not apply more than a total of 17 fl oz of Closer SC (0.266 lb ai of sulfoxaflor) per acre per year.
- Do not apply this product at any time between 3 days prior to bloom and until after petal fall.

Strawberry

Pests and Application Rates:

Pests	Closer SC (oz/acre)
plant bugs	2.75 – 4.5 (0.043 – 0.07 lb ai/acre)
thrips (suppression only)	4.5 (0.07 lb ai/acre)

Advisory Pollinator Statement: Notifying known beekeepers within 1 mile of the treatment area 48 hours before the product is applied will allow them to take additional steps to protect their bees. Also, limiting application to times when managed bees and native pollinators are least active, e.g., before 7 am or after 7 pm local time or when the temperature is below 55ºF at the site of application, will minimize risk to bees.

Application Timing: Treat in accordance with local economic thresholds. Consult your Dow AgroSciences representative, cooperative extension service, certified crop advisor or state agricultural experiment station for any additional local use recommendations for your area.

Application Rate: Use a higher rate in the rate range for heavy pest populations.

Restrictions:
- **Preharvest Interval:** Do not apply within 1 day of harvest.
- **Minimum Treatment Interval:** Do not make applications less than 7 days apart.
- Do not make more than four applications per crop.
- Do not make more than two consecutive applications per crop.
- Do not apply more than a total of 17 oz of Closer SC (0.266 lb ai of sulfoxaflor) per acre per year.

Stone Fruits (Crop Group 12)[1]

[1]Stone fruits (crop group 12) including apricot, nectarine, peach, plum, prune, sweet cherry, tart cherry

Pests and Application Rates:

Pests	Closer SC (fl oz/acre)
aphids	1.5 – 2.75 (0.023 – 0.043 lb ai/acre)
San Jose scale (suppression only) western flower thrips (suppression only)	5.75 (0.09 ai/acre)

Application Timing: Treat in accordance with local economic thresholds. Consult your Dow AgroSciences representative, cooperative extension service, certified crop advisor or state agricultural experiment station for any additional local use recommendations for your area. Time application for San Jose scale to the crawler stage.

Application Rate: Use a higher rate in the rate range for heavy pest populations.

Restrictions:
- **Preharvest Interval:** Do not apply within 7 days of harvest.
- **Minimum Treatment Interval:** Do not make applications less than 7 days apart.
- Do not make more than four applications per crop.
- Do not make more than two consecutive applications per crop.
- Do not apply more than a total of 17 fl oz of Closer SC (0.266 lb ai of sulfoxaflor) per acre per year.
- Do not apply this product at any time between 3 days prior to bloom and until after petal fall.

Tree Nuts (Crop Group 14)[1] and Pistachio

[1]Tree nuts (crop group 14) including almonds, cashew, chestnut, filbert (hazelnut), macadamia nut, pecan, walnut

Pests and Application Rates:

Pests	Closer SC (fl oz/acre)
aphids	1.5 – 2.75 (0.023 – 0.045 lb ai/acre)
San Jose scale (suppression only)	5.75 (0.09 lb ai/acre)

Application Timing: Treat in accordance with local economic thresholds. Consult your Dow AgroSciences representative, cooperative extension service, certified crop advisor or state agricultural experiment station for any additional local use recommendations for your area. Time application for San Jose scale to the crawler stage.

Application Rate: Use a higher rate in the rate range for heavy pest populations.

Restrictions:

- **Preharvest Interval:** Do not apply within 7 days of harvest.
- **Minimum Treatment Interval:** Do not make applications less than 7 days apart.
- Do not make more than four applications per crop.
- Do not make more than two consecutive applications per crop.
- Do not apply more than a total of 17 fl oz of Closer SC (0.266 lb ai of sulfoxaflor) per acre per year.
- Do not apply this product at any time between 3 days prior to bloom and until after petal fall.

Terms and Conditions of Use

If terms of the following Warranty Disclaimer, Inherent Risks of Use, and Limitation of Remedies are not acceptable, return unopened package at once to the seller for a full refund of purchase price paid. To the extent permitted by law, otherwise, use by the buyer or any other user constitutes acceptance of the terms under Warranty Disclaimer, Inherent Risks of Use and Limitation of Remedies.

Warranty Disclaimer

Dow AgroSciences warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes stated on the label when used in strict accordance with the directions, subject to the inherent risks set forth below. To the extent permitted by law, Dow AgroSciences MAKES NO OTHER EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER EXPRESS OR IMPLIED WARRANTY.

Inherent Risks of Use

It is impossible to eliminate all risks associated with use of this product. Plant injury, lack of performance, or other unintended consequences may result because of such factors as use of the product contrary to label instructions (including conditions noted on the label, such as unfavorable temperature, soil conditions, etc.), abnormal conditions (such as excessive rainfall, drought, tornadoes, hurricanes), presence of other materials, the manner of application, or other factors, all of which are beyond the control of Dow AgroSciences or the seller. To the extent permitted by law, all such risks shall be assumed by buyer.

Limitation of Remedies

To the extent permitted by law, the exclusive remedy for losses or damages resulting from this product (including claims based on contract, negligence, strict liability, or other legal theories), shall be limited to, at Dow AgroSciences' election, one of the following:

1. Refund of purchase price paid by buyer or user for product bought, or
2. Replacement of amount of product used

To the extent permitted by law, Dow AgroSciences shall not be liable for losses or damages resulting from handling or use of this product unless Dow AgroSciences is promptly notified of such loss or damage in writing. To the extent permitted by law, in no case shall Dow AgroSciences be liable for consequential or incidental damages or losses.

The terms of the Warranty Disclaimer, Inherent Risks of Use, and Limitation of Remedies cannot be varied by any written or verbal statements or agreements. No employee or sales agent of Dow AgroSciences or the seller is authorized to vary or exceed the terms of the Warranty Disclaimer or Limitation of Remedies in any manner.

®™Trademark of The Dow Chemical Company ("Dow") or an affiliated company of Dow

Produced for
Dow AgroSciences LLC
9330 Zionsville Road
Indianapolis, IN 46268

Label Code: D02-391-002
Replaces Label: D02-391-001
LOES Number: 010-02319

EPA accepted 09/29/14

Revisions:

1. Added the statement ", unless otherwise directed by a state-specific 24(c) label" to first paragraph under Chemigation Application section. Does not appear on package label.
2. Addition of Isoclast Active active ingredient descriptor.
3. Updated the Terms and Conditions and Warranty Disclaimer section

SAFETY DATA SHEET
DOW AGROSCIENCES LLC

Product name: CLOSER™ SC Insecticide

Issue Date: 05/05/2015
Print Date: 05/17/2015

DOW AGROSCIENCES LLC encourages and expects you to read and understand the entire (M)SDS, as there is important information throughout the document. We expect you to follow the precautions identified in this document unless your use conditions would necessitate other appropriate methods or actions.

1. IDENTIFICATION

Product name: CLOSER™ SC Insecticide

Recommended use of the chemical and restrictions on use
Identified uses: End use insecticide product

COMPANY IDENTIFICATION
DOW AGROSCIENCES LLC
9330 ZIONSVILLE RD
INDIANAPOLIS IN 46268-1053
UNITED STATES

Customer Information Number: 800-992-5994
info@dow.com

EMERGENCY TELEPHONE NUMBER
24-Hour Emergency Contact: 800-992-5994
Local Emergency Contact: 352-323-3500

2. HAZARDS IDENTIFICATION

Hazard classification
This material is not hazardous under the criteria of the Federal OSHA Hazard Communication Standard 29CFR 1910.1200.

Other hazards
no data available

3. COMPOSITION/INFORMATION ON INGREDIENTS

Chemical nature: Plant growth regulator
This product is a mixture.

Component	CASRN	Concentration
Sulfoxaflor	946578-00-3	21.8%

Propylene glycol	57-55-6	4.0%
Balance	Not available	74.2%

4. FIRST AID MEASURES

Description of first aid measures
General advice: If potential for exposure exists refer to Section 8 for specific personal protective equipment.

Inhalation: Move person to fresh air. If person is not breathing, call an emergency responder or ambulance, then give artificial respiration; if by mouth to mouth use rescuer protection (pocket mask etc). Call a poison control center or doctor for treatment advice.

Skin contact: Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice. Suitable emergency safety shower facility should be available in work area.

Eye contact: Hold eyes open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eyes. Call a poison control center or doctor for treatment advice. Suitable emergency eye wash facility should be available in work area.

Ingestion: No emergency medical treatment necessary.

Most important symptoms and effects, both acute and delayed: Aside from the information found under Description of first aid measures (above) and Indication of immediate medical attention and special treatment needed (below), any additional important symptoms and effects are described in Section 11: Toxicology Information.

Indication of any immediate medical attention and special treatment needed
Notes to physician: No specific antidote. Treatment of exposure should be directed at the control of symptoms and the clinical condition of the patient.

5. FIREFIGHTING MEASURES

Suitable extinguishing media: To extinguish combustible residues of this product use water fog, carbon dioxide, dry chemical or foam.

Unsuitable extinguishing media: no data available

Special hazards arising from the substance or mixture
Hazardous combustion products: Under fire conditions some components of this product may decompose. The smoke may contain unidentified toxic and/or irritating compounds. Combustion products may include and are not limited to: Sulfur oxides. Nitrogen oxides. Hydrogen fluoride. Carbon monoxide. Carbon dioxide.

Unusual Fire and Explosion Hazards: This material will not burn until the water has evaporated. Residue can burn.

Advice for firefighters

Fire Fighting Procedures: Keep people away. Isolate fire and deny unnecessary entry. Use water spray to cool fire exposed containers and fire affected zone until fire is out and danger of reignition has passed. To extinguish combustible residues of this product use water fog, carbon dioxide, dry chemical or foam. Contain fire water run-off if possible. Fire water run-off, if not contained, may cause environmental damage. Review the “Accidental Release Measures” and the “Ecological Information” sections of this (M)SDS.

Special protective equipment for firefighters: Wear positive-pressure self-contained breathing apparatus (SCBA) and protective fire fighting clothing (includes fire fighting helmet, coat, trousers, boots, and gloves). Avoid contact with this material during fire fighting operations. If contact is likely, change to full chemical resistant fire fighting clothing with self-contained breathing apparatus. If this is not available, wear full chemical resistant clothing with self-contained breathing apparatus and fight fire from a remote location. For protective equipment in post-fire or non-fire clean-up situations, refer to the relevant sections.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures: Isolate area. Keep unnecessary and unprotected personnel from entering the area. Refer to section 7, Handling, for additional precautionary measures. Use appropriate safety equipment. For additional information, refer to Section 8, Exposure Controls and Personal Protection.

Environmental precautions: Prevent from entering into soil, ditches, sewers, waterways and/or groundwater. See Section 12, Ecological Information.

Methods and materials for containment and cleaning up: Contain spilled material if possible. Small spills: Absorb with materials such as: Clay. Dirt. Sand. Sweep up. Collect in suitable and properly labeled containers. Large spills: Contact Dow AgroSciences for clean-up assistance. See Section 13, Disposal Considerations, for additional information.

7. HANDLING AND STORAGE

Precautions for safe handling: Keep out of reach of children. Do not swallow. Avoid contact with eyes, skin, and clothing. Avoid breathing vapor or mist. Wash thoroughly after handling. Keep container tightly closed. Use with adequate ventilation. Spills of these organic materials on hot fibrous insulations may lead to lowering of the autoignition temperatures possibly resulting in spontaneous combustion. See Section 8, EXPOSURE CONTROLS AND PERSONAL PROTECTION.

Conditions for safe storage: Store in a dry place. Store in original container. Keep container tightly closed when not in use. Do not store near food, foodstuffs, drugs or potable water supplies.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Control parameters

Exposure limits are listed below, if they exist.

Component	Regulation	Type of listing	Value/Notation
Propylene glycol	US WEEL	TWA	10 mg/m3

RECOMMENDATIONS IN THIS SECTION ARE FOR MANUFACTURING, COMMERCIAL BLENDING AND PACKAGING WORKERS. APPLICATORS AND HANDLERS SHOULD SEE THE PRODUCT LABEL FOR PROPER PERSONAL PROTECTIVE EQUIPMENT AND CLOTHING.

Exposure controls
Engineering controls: Use local exhaust ventilation, or other engineering controls to maintain airborne levels below exposure limit requirements or guidelines. If there are no applicable exposure limit requirements or guidelines, general ventilation should be sufficient for most operations.

Individual protection measures

Eye/face protection: Use safety glasses (with side shields).

Skin protection

Hand protection: Chemical protective gloves should not be needed when handling this material. Consistent with general hygienic practice for any material, skin contact should be minimized.

Other protection: No precautions other than clean body-covering clothing should be needed.

Respiratory protection: Respiratory protection should be worn when there is a potential to exceed the exposure limit requirements or guidelines. If there are no applicable exposure limit requirements or guidelines, wear respiratory protection when adverse effects, such as respiratory irritation or discomfort have been experienced, or where indicated by your risk assessment process. For most conditions no respiratory protection should be needed; however, if discomfort is experienced, use an approved air-purifying respirator.
The following should be effective types of air-purifying respirators: Organic vapor cartridge with a particulate pre-filter.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	
Physical state	Liquid.
Color	Tan
Odor	Mild
Odor Threshold	No test data available
pH	4.67 1% *pH Electrode*
Melting point/range	Not applicable
Freezing point	No test data available
Boiling point (760 mmHg)	No test data available
Flash point	**closed cup** > 100 °C (> 212 °F) *Closed Cup*
Evaporation Rate (Butyl Acetate = 1)	No test data available
Flammability (solid, gas)	Not applicable to liquids
Lower explosion limit	No test data available
Upper explosion limit	No test data available
Vapor Pressure	Not applicable
Relative Vapor Density (air = 1)	No test data available
Relative Density (water = 1)	1.1066
Water solubility	Not applicable

Partition coefficient: n-octanol/water	no data available
Auto-ignition temperature	350 °C (662 °F) *EC Method A15*
Decomposition temperature	No test data available
Kinematic Viscosity	no data available
Explosive properties	No
Oxidizing properties	No, No significant increase (>5C) in temperature.
Liquid Density	1.1066 g/cm3 at 20 °C (68 °F) *Digital density meter*
Molecular weight	no data available

NOTE: The physical data presented above are typical values and should not be construed as a specification.

10. STABILITY AND REACTIVITY

Reactivity: No dangerous reaction known under conditions of normal use.

Chemical stability: Thermally stable at typical use temperatures.

Possibility of hazardous reactions: Polymerization will not occur.

Conditions to avoid: Some components of this product can decompose at elevated temperatures. Generation of gas during decomposition can cause pressure in closed systems.

Incompatible materials: None known.

Hazardous decomposition products: Decomposition products depend upon temperature, air supply and the presence of other materials. Toxic gases are released during decomposition.

11. TOXICOLOGICAL INFORMATION

Toxicological information appears in this section when such data is available.

Acute toxicity

Acute oral toxicity

Very low toxicity if swallowed. Harmful effects not anticipated from swallowing small amounts.

As product:
LD50, Rat, male and female, > 5,000 mg/kg

Acute dermal toxicity

Prolonged skin contact is unlikely to result in absorption of harmful amounts.

As product:
LD50, Rat, male and female, > 5,000 mg/kg

Acute inhalation toxicity

No adverse effects are anticipated from inhalation.

As product:
LC50, Rat, male and female, 4 Hour, Aerosol, > 2.21 mg/l No deaths occurred at this concentration.
Maximum attainable concentration.

Skin corrosion/irritation
Prolonged contact is essentially nonirritating to skin.

Serious eye damage/eye irritation

May cause slight eye irritation.
Corneal injury is unlikely.

Sensitization
Did not demonstrate the potential for contact allergy in mice.

For respiratory sensitization:
No relevant data found.

Specific Target Organ Systemic Toxicity (Single Exposure)
Evaluation of available data suggests that this material is not an STOT-SE toxicant.

Specific Target Organ Systemic Toxicity (Repeated Exposure)
For the active ingredient(s):
In animals, effects have been reported on the following organs:
Liver.
For the minor component(s):
In rare cases, repeated excessive exposure to propylene glycol may cause central nervous system effects.

Carcinogenicity
For the active ingredient(s): Has caused cancer in laboratory animals. However, the effects are species specific and are not relevant to humans.

Teratogenicity
For the active ingredient(s): Has caused birth defects in lab animals at high doses. In laboratory animals, excessive doses toxic to the parent animals caused decreased weight and survival of offspring. However, the effects are species specific and are not relevant to humans. These concentrations exceed relevant human dose levels.

Reproductive toxicity
For the active ingredient(s): In animal studies, has been shown to interfere with reproduction. However, the effects are species specific and are not relevant to humans. These concentrations exceed relevant human dose levels.

Mutagenicity
Animal genetic toxicity studies were negative.

Aspiration Hazard
Based on physical properties, not likely to be an aspiration hazard.

12. ECOLOGICAL INFORMATION

Ecotoxicological information appears in this section when such data is available.

Toxicity

Acute toxicity to fish
For similar material(s):
Material is moderately toxic to aquatic organisms on an acute basis (LC50/EC50 between 1 and 10 mg/L in the most sensitive species tested).
As product:

LC50, Oncorhynchus mykiss (rainbow trout), static test, 96 Hour, > 939 mg/l, OECD Test Guideline 203

Acute toxicity to aquatic invertebrates
LC50, Daphnia magna (Water flea), static test, 48 Hour, > 880 mg/l, OECD Test Guideline 202 or Equivalent

For similar material(s):
LC50, saltwater mysid Mysidopsis bahia, 96 Hour, > 1 - < 10 mg/l

Acute toxicity to algae/aquatic plants
ErC50, diatom Navicula sp., 72 Hour, Growth rate inhibition, > 100 mg/l

Toxicity to Above Ground Organisms
Material is practically non-toxic to birds on an acute basis (LD50 > 2000 mg/kg).

LD50, Colinus virginianus (Bobwhite quail), mortality, > 2,250 mg/kg

oral LD50, Apis mellifera (bees), 48 Hour, 0.23micrograms/bee

contact LD50, Apis mellifera (bees), 48 Hour, 0.59micrograms/bee

Toxicity to soil-dwelling organisms
LC50, Eisenia fetida (earthworms), 14 d, 6.4mg/kg dry weight (d.w.)

Persistence and degradability

Sulfoxaflor

Biodegradability: Material is not readily biodegradable according to OECD/EEC guidelines.

Biodegradation: 0 %

Theoretical Oxygen Demand: 1.90 mg/mg

Photodegradation
Test Type: Half-life (indirect photolysis)
Sensitizer: OH radicals
Atmospheric half-life: 7.762 Hour
Method: Estimated.

Propylene glycol

Biodegradability: Material is readily biodegradable. Passes OECD test(s) for ready biodegradability. Biodegradation may occur under anaerobic conditions (in the absence of oxygen).
10-day Window: Pass
Biodegradation: 81 %
Exposure time: 28 d
Method: OECD Test Guideline 301F or Equivalent
10-day Window: Not applicable
Biodegradation: 96 %
Exposure time: 64 d
Method: OECD Test Guideline 306 or Equivalent

Theoretical Oxygen Demand: 1.68 mg/mg

Chemical Oxygen Demand: 1.53 mg/mg

Biological oxygen demand (BOD)

Incubation Time	BOD
5 d	69.000 %
10 d	70.000 %
20 d	86.000 %

Photodegradation
Atmospheric half-life: 10 Hour
Method: Estimated.

Balance

Biodegradability: No relevant data found.

Bioaccumulative potential

Sulfoxaflor

Bioaccumulation: Bioconcentration potential is low (BCF < 100 or Log Pow < 3).
Partition coefficient: n-octanol/water(log Pow): 0.802 at 20 °C Measured

Propylene glycol

Bioaccumulation: Bioconcentration potential is low (BCF < 100 or Log Pow < 3).
Partition coefficient: n-octanol/water(log Pow): -1.07 Measured
Bioconcentration factor (BCF): 0.09 Estimated.

Balance

Bioaccumulation: No relevant data found.

Mobility in soil

Sulfoxaflor

Potential for mobility in soil is very high (Koc between 0 and 50).
Partition coefficient(Koc): 40 Measured

Propylene glycol

Given its very low Henry's constant, volatilization from natural bodies of water or moist soil is not expected to be an important fate process.
Potential for mobility in soil is very high (Koc between 0 and 50).
Partition coefficient(Koc): < 1 Estimated.

Balance
No relevant data found.

13. DISPOSAL CONSIDERATIONS

Disposal methods: If wastes and/or containers cannot be disposed of according to the product label directions, disposal of this material must be in accordance with your local or area regulatory authorities. This information presented below only applies to the material as supplied. The identification based on characteristic(s) or listing may not apply if the material has been used or otherwise contaminated. It is the responsibility of the waste generator to determine the toxicity and physical properties of the material generated to determine the proper waste identification and disposal methods in compliance with applicable regulations. If the material as supplied becomes a waste, follow all applicable regional, national and local laws.

14. TRANSPORT INFORMATION

DOT

Not regulated for transport

Classification for SEA transport (IMO-IMDG):

Proper shipping name	ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S.(Sulfoxaflor)
UN number	UN 3082
Class	9
Packing group	III
Marine pollutant	Sulfoxaflor
Transport in bulk according to Annex I or II of MARPOL 73/78 and the IBC or IGC Code	Consult IMO regulations before transporting ocean bulk

Classification for AIR transport (IATA/ICAO):

Proper shipping name	Environmentally hazardous substance, liquid, n.o.s.(Sulfoxaflor)
UN number	UN 3082
Class	9
Packing group	III

This information is not intended to convey all specific regulatory or operational requirements/information relating to this product. Transportation classifications may vary by container volume and may be influenced by regional or country variations in regulations. Additional transportation system information can be obtained through an authorized sales or customer service representative. It is the responsibility of the transporting organization to follow all applicable laws, regulations and rules relating to the transportation of the material.

15. REGULATORY INFORMATION

OSHA Hazard Communication Standard
This product is not a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

Superfund Amendments and Reauthorization Act of 1986 Title III (Emergency Planning and Community Right-to-Know Act of 1986) Sections 311 and 312
Chronic Health Hazard

Superfund Amendments and Reauthorization Act of 1986 Title III (Emergency Planning and Community Right-to-Know Act of 1986) Section 313
This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

California Proposition 65 (Safe Drinking Water and Toxic Enforcement Act of 1986)
This product contains no listed substances known to the State of California to cause cancer, birth defects or other reproductive harm, at levels which would require a warning under the statute.

Pennsylvania (Worker and Community Right-To-KnowAct): Pennsylvania Hazardous Substances List and/or Pennsylvania Environmental Hazardous Substance List:
The following product components are cited in the Pennsylvania Hazardous Substance List and/or the Pennsylvania Environmental Substance List, and are present at levels which require reporting.

Components	CASRN
Propylene glycol	57-55-6

Pennsylvania (Worker and Community Right-To-KnowAct): Pennsylvania Special Hazardous Substances List:
To the best of our knowledge, this product does not contain chemicals at levels which require reporting under this statute.

United States TSCA Inventory (TSCA)
This product contains chemical substance(s) exempt from U.S. EPA TSCA Inventory requirements. It is regulated as a pesticide subject to Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) requirements.

Federal Insecticide, Fungicide and Rodenticide Act
EPA Registration Number: 62719-623
This chemical is a pesticide product registered by the Environmental Protection Agency and is subject to certain labeling requirements under federal pesticide law. These requirements differ from the classification criteria and hazard information required for safety data sheets, and for workplace labels of non-pesticide chemicals. Following is the hazard information as required on the pesticide label:

CAUTION

Causes moderate eye irritation

16. OTHER INFORMATION

Hazard Rating System
NFPA

Health	Fire	Reactivity
1	1	0

Revision
Identification Number: 101191190 / A211 / Issue Date: 05/05/2015 / Version: 3.0
DAS Code: GF-2032
Most recent revision(s) are noted by the bold, double bars in left-hand margin throughout this document.

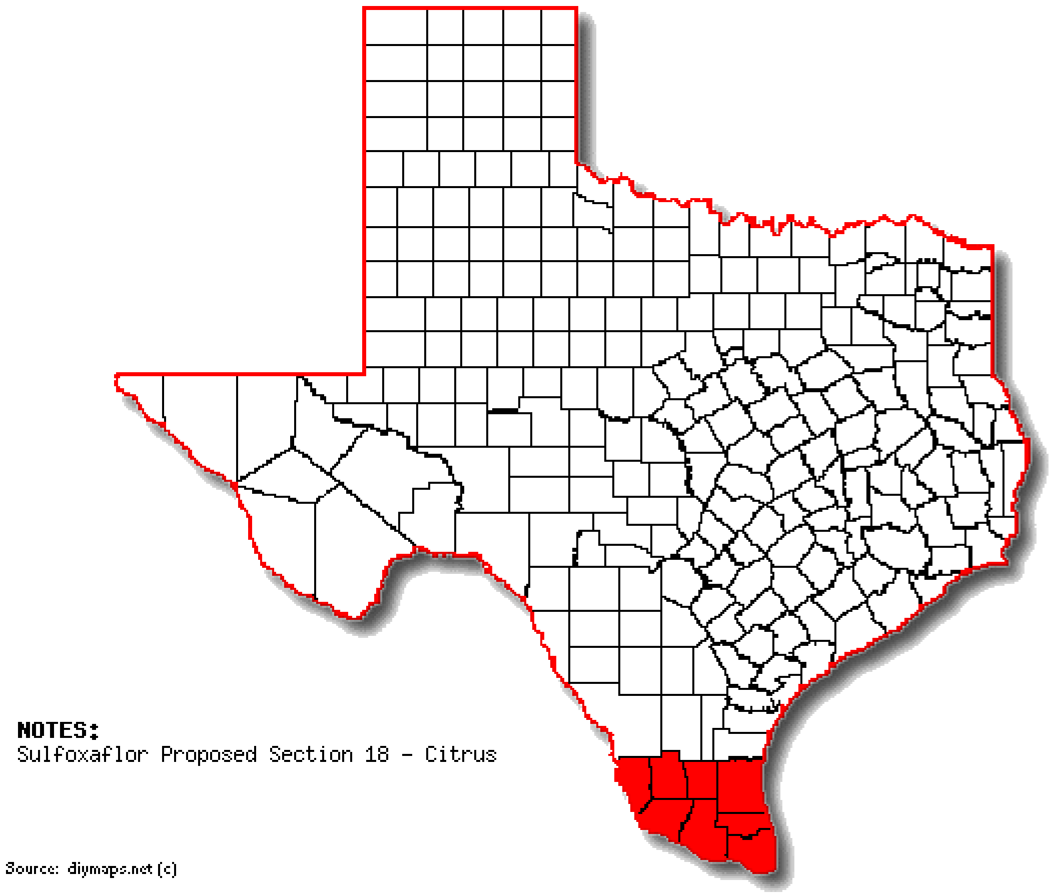
Legend

TWA	8-hr TWA
US WEEL	USA. Workplace Environmental Exposure Levels (WEEL)

Information Source and References
This SDS is prepared by Product Regulatory Services and Hazard Communications Groups from information supplied by internal references within our company.

DOW AGROSCIENCES LLC urges each customer or recipient of this (M)SDS to study it carefully and consult appropriate expertise, as necessary or appropriate, to become aware of and understand the data contained in this (M)SDS and any hazards associated with the product. The information herein is provided in good faith and believed to be accurate as of the effective date shown above. However, no warranty, express or implied, is given. Regulatory requirements are subject to change and may differ between various locations. It is the buyer's/user's responsibility to ensure that his activities comply with all federal, state, provincial or local laws. The information presented here pertains only to the product as shipped. Since conditions for use of the product are not under the control of the manufacturer, it is the buyer's/user's duty to determine the conditions necessary for the safe use of this product. Due to the proliferation of sources for information such as manufacturer-specific (M)SDSs, we are not and cannot be responsible for (M)SDSs obtained from any source other than ourselves. If you have obtained an (M)SDS from another source or if you are not sure that the (M)SDS you have is current, please contact us for the most current version.

Sulfoxaflor Proposed Section 18 Use Area - 2016



County List
Sulfoxaflor – Citrus Section 18 Request

.

Citrus Producing Counties in Texas:

Brooks,

Cameron,

Hidalgo,

Jim Hogg,

Kenedy,

Starr,

Willacy,

and Zapata

Dow AgroSciences

9330 Zionsville Road Indianapolis, IN 46268 USA

www.dowagro.com

October 20, 2016

Kevin D. Haack
Texas Department of Agriculture
P. O. Box 12847
Austin, TX 78711

Re: Support letter for Closer™ SC Section 18 in citrus

Dear Mr. Haack,

Per your request, this letter is to confirm that Dow AgroSciences supports the pursuit of a Section 18 exemption for Closer SC to control Asian citrus psyllid in citrus in Texas. Closer SC has provided excellent control of Asian citrus psyllid under previous Section 3 uses. The active ingredient, sulfoxaflor, controls pests resistant to other classes of chemistry, and has minimal impact on non-target insects, among other benefits. The recently renewed Section 3 label does not include citrus.

If you have questions, please do not hesitate to contact me.

Sincerely,

Jamey Thomas, Ph.D.
US Regulatory Manager
Dow AgroSciences

cc: Tami Jones-Jefferson, DAS

Texas Citrus Mutual
901 Business Park Drive, Suite 400
Mission, Texas 78572
TEL: (956) 584-1772 • FAX: (956) 584-3307
www.valleyag.org

Dale Murden
President

April 8, 2016

Dale Scott
Pesticide registration specialist
Texas Department of Agriculture
P.O. Box 12847
Austin, Texas 78711

Dear Mr. Scott,

On behalf of the Texas citrus growers, the Texas Citrus Mutual is seeking a Section 18 Emergency Use Registration in Texas for the continued use of Closer® (sulfoxaflor) in order to obtain adequate control of Asian Citrus Psyllid, an insect vector for Huanglongbing (also known as citrus greening disease). This disease can potentially destroy the Texas citrus industry if the insect vector is not properly controlled.

Systemic insecticides in combination with timely foliar treatments are essential to controlling the psyllid. Texas growers are achieving very good control when rotating Closer® with other forms of insecticidal prevention. The challenge growers are having is ensuring enough insecticides are in rotation to prevent resistance. Research in Texas shows Closer® has proven to be efficacious in the control of psyllid populations, barnacle scale and mealy bug populations as shown in the efficacy data provided by scientists studying Asian Citrus Psyllid control. Texas Citrus Mutual works very closely with Dr. Mamoudou Setamou, citrus entomologist with the Texas A&M Kingsville Citrus Center who has done extensive research on Closer® and he will be submitting his results on the efficacy of this product as part of this requested label change.

Texas Citrus Mutual along with the support of the Texas citrus growers strongly urge the Texas Department of Agriculture and the Environmental Protection Agency to provide an emergency use request for the use of Closer® for Asian Citrus Psyllid and other pest control. We appreciate your attention to this matter.

Sincerely,

Dale Murden

TEXAS CITRUS MUTUAL
901 BUSINESS PARK DRIVE, SUITE 400
MISSION, TEXAS 78572
PH: (956) 584-1772 • FAX: (956) 584-3307

Dale Murden
President

Dale R. Scott
Director for Environmental and Biosecurity Programs
Texas Department of Agriculture
P.O. Box 12847
Austin, TX 78711
(512) 936-2535 Phone
(888) 216-9860 Fax
dale.scott@TexasAgriculture.gov

April 12, 2016

Dear Mr. Scott:

The Texas citrus industry is faced with the most serious disease and possibly most dangerous threat in many years or possibly ever faced, citrus greening. This disease has plagued the Florida citrus industry and threatens its very survival. The disease was detected in Texas in January 2012, and has since spread to many groves and residential areas. Once a tree is infected there is no treatment except to remove the tree and control the psyllid vector to eliminate or reduce the spread of the disease.

Since 2009, Texas citrus growers have proactively implemented an area-wide control program of the Asian citrus psyllid which has led to significant reductions of psyllid populations throughout the entire citrus production area. Why is this important? Asian citrus psyllids are the source of the spread of citrus greening. Effective psyllid control is achieved using several insecticides to reduce the possibility of resistance and to control other pests that are within the groves at the same timeframe. Closer (a.i. sulfoxaflor) has proven to be efficacious in the control of psyllids and other pests. Closer has a different mode of action and is an important tool for psyllid control and resistance management programs as it allows a good rotation with other classes of insecticides for psyllid control. Our pest control guide provided to growers to aid in pest management clearly states it should be used after bloom to reduce the risk of possible pollinator contact. Unfortunately Closer was pulled off the market by EPA and we believed that this decision will negatively affect growers in our constant fight against pests and diseases in groves. We believe that the registration of Closer would enhance the control of Asian citrus psyllid and reduce the spread of citrus greening.

As a grower, I am writing this letter to support the registration request of Closer (even as a Section 18) to ensure that it is available for all citrus growers in Texas. Without the use of this product we may as well through in the towel and give up on the industry that provides our families with jobs and food.

Thank you for your consideration of this request.

Sincerely,

Fred G. Karle
Chairman of Board of Directors

April 12, 2016

Dale R. Scott
Director for Environmental and Biosecurity Programs
Texas Department of Agriculture
P.O. Box 12847
Austin, TX 78711
(512) 936-2535 Phone
(888) 216-9860 Fax
dale.scott@TexasAgriculture.gov

Dear Mr. Scott:

The Texas citrus industry is faced with the most serious disease and possibly most dangerous threat in many years or possibly ever faced, citrus greening. This disease has plagued the Florida citrus industry and threatens its very survival. The disease was detected in Texas in January 2012, and has since spread to many groves and residential areas. Once a tree is infected there is no treatment except to remove the tree and control the psyllid vector to eliminate or reduce the spread of the disease.

Since 2009, Texas citrus growers have proactively implemented an area-wide control program of the Asian citrus psyllid which has led to significant reductions of psyllid populations throughout the entire citrus production area. Why is this important? Asian citrus psyllids are the source of the spread of citrus greening. Effective psyllid control is achieved using several insecticides to reduce the possibility of resistance and to control other pests that are within the groves at the same timeframe. Closer (a.i. sulfoxaflor) has proven to be efficacious in the control of psyllids and other pests. Closer has a different mode of action and is an important tool for psyllid control and resistance management programs as it allows a good rotation with other classes of insecticides for psyllid control. Our pest control guide provided to growers to aid in pest management clearly states it should be used after bloom to reduce the risk of possible pollinator contact. Unfortunately Closer was pulled off the market by EPA and we believed that this decision will negatively affect growers in our constant fight against pests and diseases in groves. We believe that the registration of Closer would enhance the control of Asian citrus psyllid and reduce the spread of citrus greening.

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Dale R. Scott
Director for Environmental and Biosecurity Programs
Texas Department of Agriculture
P.O. Box 12847
Austin, TX 78711
(512) 936-2535 Phone
(888) 216-9860 Fax
dale.scott@TexasAgriculture.gov

April 12, 2016

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As a grower, I am writing this letter to support the registration request of Closer (even as a Section 18) to ensure that it is available for all citrus growers in Texas. Without the use of this product we may as well through in the towel and give up on the industry that provides our families with jobs and food.

Thank you for your consideration of this request.

Sincerely,

Susan Kawamoto
Kawamoto Farms

April 12, 2016

Dale R. Scott
Director for Environmental and Biosecurity Programs
Texas Department of Agriculture
P.O. Box 12847
Austin, TX 78711
(512) 936-2535 Phone
(888) 216-9860 Fax
dale.scott@TexasAgriculture.gov

Dear Mr. Scott:

The Texas citrus industry is faced with the most serious disease and possibly most dangerous threat in many years or possibly ever faced, citrus greening. This disease has plagued the Florida citrus industry and threatens its very survival. The disease was detected in Texas in January 2012, and has since spread to many groves and residential areas. Once a tree is infected there is no treatment except to remove the tree and control the psyllid vector to eliminate or reduce the spread of the disease.

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As a grower, I am writing this letter to support the registration request of Closer (even as a Section 18) to ensure that it is available for all citrus growers in Texas. Without the use of this product we may as well through in the towel and give up on the industry that provides our families with jobs and food.

Thank you for your consideration of this request.

Sincerely,

Stephen Way

FARM
BUREAU
HIDALGO COUNTY

Dale R. Scott

Director for Environmental and Biosecurity Programs

Texas Department of Agriculture

P.O Box 12847

Austin, TX. 78711

Mr. Scott,

The purpose of this correspondence is to support the request for a Section 18 for Closer (sulfoxaflor) for use on citrus to control the Asian citrus psyllid in the Rio Grande Valley of Texas.

As you know, the citrus industry is in a fight for it's very survival due to the presence of Citrus Greening Disease in this area and the critical need to control the Asian citrus psyllid, the insect which spreads that devastating disease.

We believe that precautions to protect honeybees will be appropriate and still allow for this chemistry to effectively aid in the control of the psyllid in citrus.

Regards,

Donald Kelley

Donald Kelley, Board President

P.O. BOX 1699
PHARR, TX 78577-1630

O 956.787.8844
F 956.787.0942

507 E EXPRESSWAY 83
PHARR, TX 78577

Dale R. Scott April 7, 2016
Director for Environmental and Biosecurity Programs
Texas Department of Agriculture
P.O. Box 12847
Austin, TX 78711
(512) 936-2535 Phone
(888) 216-9860 Fax
dale.scott@TexasAgriculture.gov

Dear Dale:

The U.S. citrus industry is faced with the most serious disease threat in many years and many think the most dangerous we have ever faced. The disease is Huanglongbing or Citrus Greening. This disease has devastated the Florida citrus industry and threatens its very survival. The disease has been detected in Texas in January 2012, and has since spread to many groves and residential areas. As you are well aware, once a tree is infected there is no treatment except to remove the tree and control the psyllid vector to eliminate or reduce the spread of the disease.

Since 2009, Texas citrus growers have initiated the implementation of an area-wide control of the Asian citrus psyllid and this proactive psyllid control program has led to significant reductions of psyllid populations throughout the entire citrus production area. Effective psyllid control is achieved using several insecticides. Closer (a.i. sulfoxaflor) has proven to be efficacious in the control of psyllid populations as shown in the accompanying efficacy data for a trial conducted in 2013. We have tested Closer as a number compound before its first registration, and we continuously tested it and made recommendations for its use by growers when it became commercially available. Our pest control guide clearly mentioned it to growers. Closer has a different mode of action and is an important tool for psyllid control and resistance management programs as it allows a good rotation with other classes of insecticides for psyllid control. Unfortunately Closer was pulled off the market by EPA and we believed that this decision will negatively affect our growers in their constant fight against pests and diseases in groves. We believe that the registration of Closer would enhance the control of Asian citrus psyllid and reduce the spread of Huanglongbing.

We are writing this letter to support the registration request of Closer (even as a Section 18) to ensure that it is available for citrus growers in Texas. Attached is the field trial data in support of this request.

Thank you for your consideration of this request.

Sincerely,

Mamoudou Sétamou

Mamoudou Sétamou

Efficacy testing of Sulfoxaflor against Asian citrus psyllid in Texas

Company	Location	Trial	Chemicals tested	Code
Dow	**Ramsayer, TX**	**ACP**	**Closer, Delegate, Movento**	NA13C1C005

Objectives:
Test the efficacy of SULFOXAFLOR for the control of Asian citrus psyllid in Texas and compare it with currently used insecticides such as Delegate and Movento.

Treatments:

Chemical	Rate/Ac	Adjuvant
Closer	3 fl oz	2% Petroleum Spray Oil
Delegate	4 oz	2% Petroleum Spray Oil
Closer	4 fl oz	-
Movento	10 fl oz	0.25%v/v Activator 90
Closer	4 fl oz	0.25%v/v Activator 90
Untreated control	-	-

Methods of application:
Airblast sprayer delivering a total spray volume of 200 gal per ac., on mature citrus trees

Experimental Design:
A randomized block with 4 replications per treatment was used. Each treatment was applied to a two-row plot of 40 trees within each block.

Data collection:
Twenty flush shoots were carefully examined *in situ* prior to treatment application and weekly after chemical application for 6 consecutive weeks. Data were recorded on number of Asian citrus adults, nymphs and eggs recorded.

Data Analysis:
An analysis of variance (ANOVA) was performed for each psyllid parameter for each of the sampling dates. Whenever significant *F*-values were obtained, treatment means were separated using the Student Newman Keuls test.

Main Findings:
Adult psyllid populations were relatively low at the onset of the trial, but rapidly increased in the untreated control. Such an increase in psyllid populations was not observed in all other treatments suggesting that insecticides were effective at controlling adult populations. Similarly, the numbers of psyllid nymphs were significantly reduced by all insecticide applications. However, the most effective treatment was Closer applied at the rate of 4 fl oz per acre plus 2% (v/v) oil, suggesting addition of oil will improve the effectiveness of Closer for psyllid control.

These findings clearly showed that Closer is an effective insecticide that can assist citrus growers in the control of Asian citrus psyllid. Since sulfoxaflor has a different mode of action as compared to currently used insecticides, it can be integrated into IPM program for psyllid control and be instrumental in resistance management programs.

File:Dow ACP Ramsayer Road (NA13C1C005)

Table 1. Citrus Asian Psyllid in sprayed and unsprayed Grapefruit trees, Kenyon Road, Texas Monte Cristo, TX. 2013.

	Mean No. ACP adults						
			DAT: [z]				
Treatment [y]	Precount 3/25	4/2	4/9	4/15	5/2	5/13	5/20
Closer @ 3 fl oz + oil 2 %	0.1	0.0 a	0.0 b	0.1 b	0.0 b	0.0 a	4.7 ab
Delegate @ 4 oz + oil @ 2%	0.1	0.0 a	0.0 b	0.0 b	0.0 b	0.0 a	3.0 ab
Closer @ 4 fl oz	0.1	0.1 a	0.0 b	0.0 b	0.0 b	0.0 a	2.7 b
Movento @ 10 fl oz + Activator 90 @ 0.25 % v/v	0.1	0.03 a	0.0 b	0.0 b	0.0 b	0.0 a	8.7 a
Closer @ 4 fl oz + Activator 90 @ 0.25% v/v	0.1	0.1 a	0.4 b	0.0 b	0.03 b	0.0 a	6.2 a
Control	0.1	0.2 a	2.1 a	5.3 a	3.6 a	0.3 a	5.8 a

[Z] Days After Treatment.
[Y] Treatment sprays applied 27th March, 19th April 2013, with each treatment on 2 row plot (40 trees per plot)
[X] Treatment means within columns not sharing a common letter are significantly different as separated by SNK Test (P<0.05).

File:Dow ACP Ramsayer Road (NA13C1C005)

Table 2. Citrus Asian Psyllid in sprayed and unsprayed Grapefruit trees, Kenyon Road, Texas Monte Cristo, TX. 2013.

		Mean No. ACP Nymphs					
		DAT: [z]					
Treatment [y]	Precount 3/25	4/2	4/9	4/15	5/2	5/13	5/20
Closer @ 3 fl oz + oil 2 %	4.2	0.2 b	0.1 c	3.4 bc	0.03 b	0.0 a	10.2 b
Delegate @ 4 oz + oil @ 2%	4.2	0.1 b	0.03 c	1.2 c	0.0 b	0.0 a	13.5 b
Closer @ 4 fl oz	4.2	1.5 b	3.7 ab	8.4 b	0.03 b	0.0 a	8.3 b
Movento @ 10 fl oz + Activator 90 @ 0.25 % v/v	4.2	0.2 b	2.5 b	3.1 c	0.03 b	0.0 a	14.0 b
Closer @ 4 fl oz + Activator 90 @ 0.25% v/v	4.2	1.1 b	3.5 ab	8.0 c	0.0 b	0.0 a	40.3 a
Control	4.2	8.7 a	5.5 a	17.7 a	6.0 a	0.0 a	41.8 a

[Z] Days After Treatment.
[Y] Treatment sprays applied 27th March, 19th April 2013, with each treatment on 2 row plot (40 trees per plot)
[X] Treatment means within columns not sharing a common letter are significantly different as separated by SNK Test (P<0.05).

ELECTRONIC CODE OF FEDERAL REGULATIONS

e-CFR data is current as of September 26, 2016

Title 40 → Chapter I → Subchapter E → Part 180 → Subpart C → §180.668

Title 40: Protection of Environment
PART 180—TOLERANCES AND EXEMPTIONS FOR PESTICIDE CHEMICAL RESIDUES IN FOOD
Subpart C—Specific Tolerances

§180.668 Sulfoxaflor; tolerances for residues.

(a) *General.* Tolerances are established for residues of the insecticide sulfoxaflor, including its metabolites and degradates, in or on the commodities in the table. Compliance with the tolerance levels specified is to be determined by measuring only sulfoxaflor (*N*-[methyloxido[1-[6-(trifluoromethyl)-3-pyridinyl]ethyl]-γ^4-sulfanylidene]cyanamide).

Commodity	Parts per million
Almond, hulls	6.0
Barley, grain	0.40
Barley, hay	1.0
Barley, straw	2.0
Bean, dry seed	0.20
Bean, succulent	4.0
Beet, sugar, dried pulp	0.07
Beet, sugar, molasses	0.25
Berry, low growing, subgroup 13-7G	0.70
Cattle, fat	0.10
Cattle, meat	0.15
Cattle, meat byproducts	0.40
Cauliflower	0.08
Citrus, dried pulp	3.6
Cotton, gin byproducts	6.0
Cotton, hulls	0.35
Cottonseed subgroup 20C	0.20
Fruit, citrus, group 10-10	0.70
Fruit, pome, group 11-10	0.50
Fruit, small, vine climbing, subgroup 13-07F, except fuzzy kiwi fruit	2.0
Fruit, stone, group 12	3.0
Goat, fat	0.10
Goat, meat	0.15
Goat, meat byproducts	0.40
Grain, aspirated fractions	20.0
Grape, raisin	6.0
Hog, fat	0.01
Hog, meat	0.01
Hog, meat byproducts	0.01
Horse, fat	0.10
Horse, meat	0.15
Horse, meat byproducts	0.40
Leafy greens, subgroup 4A	6.0
Leafy petiole, subgroup 4B	2.0
Milk	0.15
Nuts, tree, group 14	0.015
Onion, bulb, subgroup 3-07A	0.01
Onion, green, subgroup 3-07B	0.70
Pistachio	0.015
Poultry, eggs	0.01
Poultry, fat	0.01
Poultry, meat	0.01
Poultry, meat byproducts	0.01
Rapeseed, meal	0.50
Rapeseed subgroup 20A	0.40
Sheep, fat	0.10

Sheep, meat	0.15
Sheep, meat byproducts	0.40
Soybean, seed	0.20
Tomato, paste	2.60
Tomato, puree	1.20
Vegetable, *brassica,* leafy, group 5, except cauliflower	2.0
Vegetable, cucurbit, group 9	0.40
Vegetable, fruiting, group 8-10	0.70
Vegetable, leaves of root and tuber, group 2	3.0
Vegetable, legume, foliage, group 7	3.0
Vegetable, root and tuber, group 1	0.05
Watercress	6.0
Wheat, forage	1.0
Wheat, grain	0.08
Wheat, hay	1.5
Wheat, straw	2.0

(b) *Section 18 emergency exemptions.* Time-limited tolerances specified in the following table are established for residues of sulfoxaflor (*N*-[methyloxido[1-[6-(trifluoromethyl)-3-pyridinyl]ethyl]- λ^4-sulfanylidene]cyanamide), including its metabolites and degradates, in or on the specified agricultural commodities, resulting from use of the pesticide pursuant to FIFRA section 18 emergency exemptions. Compliance with the tolerance levels specified in the following table is to be determined by measuring only sulfoxaflor in or on the commodity. The tolerances expire on the date specified in the table.

Commodity	**Parts per million**	**Expiration/revocation date**
Sorghum, forage	0.40	12/31/17
Sorghum, grain	0.30	12/31/17
Sorghum, stover	0.90	12/31/17

(c) *Tolerances with regional registrations.* [Reserved]

(d) *Indirect or inadvertent residues.* [Reserved]

[77 FR 59565, Sept. 28, 2012, as amended at 78 FR 38227, June 26, 2013; 80 FR 4515, Jan. 28, 2015]

Need assistance?

TEXAS DEPARTMENT OF AGRICULTURE
COMMISSIONER SID MILLER

January 19, 2017

Ms. Kathy Boydston
Wildlife Division - Habitat Assessment
Texas Parks & Wildlife Department
4200 Smith School Road
Austin, TX 78744

Dear Ms. Boydston:

This is to advise your agency that the Texas Department of Agriculture (TDA) has submitted an application to the U. S. Environmental Protection Agency (EPA) for an emergency specific exemption to authorize the use of sulfoxaflor (Closer® SC Insecticide, EPA Reg. No. 62719-623) to manage the transmission of Huanglongbing (HLB) disease by controlling the Asian citrus psyllid (ACP) on immature citrus trees in commercial groves in Texas. This action is pursuant to the authority of FIFRA Section 18. A copy of the proposed Section 18 Use Map and draft Use Directions are included for your reference.

Section 166.20(a)(8) of Title 40, Code of Federal Registration requires that your agency be notified of this action. Any comments your agency may have relative to the application noted above should be sent to my attention

If you have any questions, please contact me at (512) 463-6982.

Sincerely,

Kevin Haack
Coordinator for Pesticide Product Evaluation and Registration
Kevin.Haack@TexasAgriculture.gov

KH/kh

Enclosure:
Proposed Section 18 Use Map
Sulfoxaflor – Citrus Draft Section 18 Use Directions

TEXAS DEPARTMENT OF AGRICULTURE
COMMISSIONER SID MILLER

January 19, 2017

Mr. Al Cherepon
Water Planning & Assessment
Texas Commission on Environmental Quality
P.O. Box 13087
Austin, TX 78711-3087

Dear Mr. Cherepon:

This is to advise your agency that the Texas Department of Agriculture (TDA) has submitted an application to the U. S. Environmental Protection Agency (EPA) for an emergency specific exemption to authorize the use of sulfoxaflor (Closer® SC Insecticide, EPA Reg. No. 62719-623) to manage the transmission of Huanglongbing (HLB) disease by controlling the Asian citrus psyllid (ACP) on immature citrus trees in commercial groves in Texas. This action is pursuant to the authority of FIFRA Section 18. A copy of the proposed Section 18 Use Map and draft Use Directions are included for your reference.

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Sincerely,

Kevin Haack
Coordinator for Pesticide Product Evaluation and Registration
Kevin.Haack@TexasAgriculture.gov

KH/kh

Enclosure:
Proposed Section 18 Use Map
Sulfoxaflor – Citrus Draft Section 18 Use Directions

TEXAS DEPARTMENT OF AGRICULTURE
COMMISSIONER SID MILLER

January 19, 2017

Dr. Jong Song Lee
MC 168, Toxicology
Texas Commission on Environmental Quality
P.O. Box 13087
Austin, TX 78711-3087

Dear Dr. Lee:

This is to advise your agency that the Texas Department of Agriculture (TDA) has submitted an application to the U. S. Environmental Protection Agency (EPA) for an emergency specific exemption to authorize the use of sulfoxaflor (Closer® SC Insecticide, EPA Reg. No. 62719-623) to manage the transmission of Huanglongbing (HLB) disease by controlling the Asian citrus psyllid (ACP) on immature citrus trees in commercial groves in Texas. This action is pursuant to the authority of FIFRA Section 18. A copy of the proposed Section 18 Use Map and draft Use Directions are included for your reference.

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Sincerely,

Kevin Haack
Coordinator for Pesticide Product Evaluation and Registration
Kevin.Haack@TexasAgriculture.gov

KH/kh

Enclosures:
Proposed Section 18 Use Map
Sulfoxaflor – Citrus Draft Section 18 Use Directions

TEXAS DEPARTMENT OF AGRICULTURE
COMMISSIONER SID MILLER

January 19, 2017

Mr. Adam Zerrenner
Assistant Field Supervisor
U.S. Fish and Wildlife Service
Hartland Bank Building
10711 Burnet Road, Ste.200
Austin, Texas 78758

Dear Mr. Zerrenner:

This is to advise your agency that the Texas Department of Agriculture (TDA) has submitted an application to the U. S. Environmental Protection Agency (EPA) for an emergency specific exemption to authorize the use of sulfoxaflor (Closer® SC Insecticide, EPA Reg. No. 62719-623) to manage the transmission of Huanglongbing (HLB) disease by controlling the Asian citrus psyllid (ACP) on immature citrus trees in commercial groves in Texas. This action is pursuant to the authority of FIFRA Section 18. A copy of the proposed Section 18 Use Map and draft Use Directions are included for your reference.

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Sincerely,

Kevin Haack
Coordinator for Pesticide Product Evaluation and Registration
Kevin.Haack@TexasAgriculture.gov

KH/kh

Enclosures:
Proposed Section 18 Use Map
Sulfoxaflor – Citrus Draft Section 18 Use Directions

Economic Impacts of Greening on the Texas Citrus Industry, CNAS Issue Brief 2007-01

February 12, 2007

Introduction

Greening is a serious threat to the Texas citrus industry. Citrus greening, an insect borne bacteria, was first documented in India in the 1700s and China in the early 1900s. It is spread by two species of citrus psyllid, Asian and African. The Asian psyllid was discovered in Florida in 1998 and Texas in 2001. Greening was discovered in Florida in 2005, but due to the latent nature of infestation, it was likely introduced a few years before. The Asian psyllid is widespread in Texas, but the disease has not yet been discovered. Greening could threaten the Texas citrus industry if effective treatments and controls are not developed. The bacteria renders infected trees useless and reduces the marketability of citrus because the fruit is small, misshapen and remains green, and the juice is bitter. Trees normally die within 3-5 years after infection is detected. There is currently no known cure for greening and the only treatment is control of the citrus psyllid or removal of infected trees. Greening has also been found in Asia, Africa, the Arabian Peninsula, and Brazil. The bacteria is not harmful to humans.

Texas commercial citrus production was valued at $74 million in 2006 and averaged $81.3 million over the last two seasons. Production is located in the Lower Rio Grande Valley, with Hidalgo county accounting for about 88 percent of Texas bearing acres in 2002. Texas is the third largest citrus producing state behind Florida and California.

The economic impacts of greening on the Texas commercial citrus industry were estimated using IMPLAN. Economic multipliers for each sector of the economy were used to estimate how a change in one sector affects business activity, income and employment in other sectors of the economy that supply inputs and services to the citrus industry. Baseline economic impacts were estimated for the value of annual average Texas citrus production for the crop years of 2004/05 and 2005/06.

Current Situation and Economic Baseline

IMPLAN estimates indicate that total business activity required to support the Texas citrus industry was $121.3 million annually. This includes post farm-gate business activity of $41.9 million and farm level business activity of $79.4 million. Farm and related sector income generated by citrus production was $50.9 million, while another $24.5 million was generated off farm in transportation, handling, processing and marketing. Total employment associated with the Texas citrus industry was estimated to be 1,911 jobs. Farm employment represented 1,217 of those jobs. The balance of employment, 694 jobs, is located in non-farm sectors of the Texas economy. The most important non-farm sectors are: agriculture support services such as sorting, grading, cleaning and packing, 287 jobs; food and beverages, 59 jobs; medical services, 55 jobs; and wholesale trade, 24 jobs.

Significant indirect spending associated with the Texas citrus industry is dispersed over numerous sectors supplying goods and services required to support the production and marketing of fresh and processed citrus in Texas. Business activity associated with the most important supporting sectors is: agriculture support activities, $7.2 million; wholesale trade, $2.6 million; real estate, $1.2 million; truck transportation, $760 thousand; and farm machinery, $215 thousand. Health care services at $4 million, food and beverage sales at $2.6 million, and insurance and banking services at $2 million, are supported by household incomes generated from economic activity associated with the Texas citrus industry.

Potential Economic Impacts of Citrus Greening

Industry experts estimate that infestations of citrus greening may reduce the value of Texas citrus production by 20 percent after two years of infestation and up to 60 percent after five years. Sustained production losses at these levels would have substantial economic impacts on Texas. The following summarizes the economic losses attributed to each level of loss. These results assume no action is taken to reduce the presence of the citrus psyllid or to otherwise mitigate the effects of greening.

20 Percent Reduction in Citrus Production Value

After two years of infestation, losses in business activity associated with a 20 percent reduction in citrus production value would be $23.7 million. Of this total, $15.5 million would be losses of farm level economic activity supporting citrus production. An additional $8.2 million in business activity would be lost in associated non-farm activities. Total income losses would be $14.7 million, with $9.9 million in losses occurring in farming and related activities and another $4.8 million in non-farm activities. Total job losses are estimated to reach 373, with farm job losses of 237 and non-farm job losses of 136.

Non-farm losses of business activity are estimated to be substantial and are due to reduced income associated with lost employment. About $791 thousand in lost sales would occur throughout the medical sectors and $144 thousand in the food/beverage sector. Real estate losses would reach $233 thousand, while losses to banking and insurance would exceed $378 thousand. Food service losses would be about $362 thousand. Losses in business activity attributable to reduced citrus sales by farmers would be largest in agriculture support activities, $1.4 million. Losses in wholesale trade would be about $500,000.

60 Percent Reduction in Citrus Production Value

After five years of infestation, greening would reduce citrus production value by an estimated 60 percent. Total business activity would decline by $68.5 million, while income would fall by an additional $42.6 million. Total job losses would reach 1,080. Business activity associated with agriculture support activities is estimated to decline $4.1 million, the largest losses of any single sector. About $3.5 million would be lost in real estate. Medical service business activity would decline $1.7 million and food service $1.4 million. Greenhouse/nursery would fall $128,000 while farm machinery and equipment would drop $121,000. Job losses in citrus production would reach 688, while agriculture support activity would lose 162 jobs.

These potential economic impacts on the Texas citrus industry represent what could occur if greening emerges and is not controlled and eventually eliminated. Greening can result in the complete loss of citrus trees and associated acreage resulting in loss of specialized infrastructure and leading to the decline of the entire industry. If this occurs, the economic impacts would be more severe, leading to greater losses in business activity, income and employment.

Prepared at the request of Texas Citrus Mutual. For further information, please contact Parr Rosson, Extension Economist and Director, Center for North American Studies, Department of Agricultural Economics, Texas A&M University, College Station, Texas 77843-2124. Telephone 979-845-3070 or e-mail prosson@tamu.edu. Contributing to this report were Michelle Niemeyer, Extension Program Specialist, Marco Palma, Extension Economist-Horticultural Marketing, Luis Ribera, Extension Economist-Management, and Flynn Adcock, International Program Coordinator.

BROOKS COUNTY

AMPHIBIANS

		Federal Status	State Status
Black-spotted newt	*Notophthalmus meridionalis*		T

can be found in wet or sometimes wet areas, such as arroyos, canals, ditches, or even shallow depressions; aestivates in the ground during dry periods; Gulf Coastal Plain south of the San Antonio River

Sheep frog	*Hypopachus variolosus*		T

predominantly grassland and savanna; moist sites in arid areas

BIRDS

		Federal Status	State Status
American Peregrine Falcon	*Falco peregrinus anatum*	DL	T

year-round resident and local breeder in west Texas, nests in tall cliff eyries; also, migrant across state from more northern breeding areas in US and Canada, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.

Arctic Peregrine Falcon	*Falco peregrinus tundrius*	DL	

migrant throughout state from subspecies' far northern breeding range, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.

Audubon's Oriole	*Icterus graduacauda audubonii*		

scrub, mesquite; nests in dense trees, or thickets, usually along water courses

Cactus Ferruginous Pygmy-Owl	*Glaucidium brasilianum cactorum*		T

riparian trees, brush, palm, and mesquite thickets; during day also roosts in small caves and recesses on slopes of low hills; breeding April to June

Mountain Plover	*Charadrius montanus*		

breeding: nests on high plains or shortgrass prairie, on ground in shallow depression; nonbreeding: shortgrass plains and bare, dirt (plowed) fields; primarily insectivorous

Northern Aplomado Falcon	*Falco femoralis septentrionalis*	LE	E

open country, especially savanna and open woodland, and sometimes in very barren areas; grassy plains and valleys with scattered mesquite, yucca, and cactus; nests in old stick nests of other bird species

Northern Beardless-Tyrannulet	*Camptostoma imberbe*		T

mesquite woodlands; near Rio Grande frequents cottonwood, willow, elm, and great leadtree; breeding April to July

BROOKS COUNTY

BIRDS

		Federal Status	State Status
Peregrine Falcon	*Falco peregrinus*	DL	T

both subspecies migrate across the state from more northern breeding areas in US and Canada to winter along coast and farther south; subspecies (F. p. anatum) is also a resident breeder in west Texas; the two subspecies' listing statuses differ, F.p. tundrius is no longer listed in Texas; but because the subspecies are not easily distinguishable at a distance, reference is generally made only to the species level; see subspecies for habitat.

Sennett's Hooded Oriole	*Icterus cucullatus sennetti*		

often builds nests in and of Spanish moss (Tillandsia unioides); feeds on invertebrates, fruit, and nectar; breeding March to August

Sprague's Pipit	*Anthus spragueii*		

only in Texas during migration and winter, mid September to early April; short to medium distance, diurnal migrant; strongly tied to native upland prairie, can be locally common in coastal grasslands, uncommon to rare further west; sensitive to patch size and avoids edges.

Texas Botteri's Sparrow	*Aimophila botterii texana*		T

grassland and short-grass plains with scattered bushes or shrubs, sagebrush, mesquite, or yucca; nests on ground of low clump of grasses

Western Burrowing Owl	*Athene cunicularia hypugaea*		

open grasslands, especially prairie, plains, and savanna, sometimes in open areas such as vacant lots near human habitation or airports; nests and roosts in abandoned burrows

White-tailed Hawk	*Buteo albicaudatus*		T

near coast on prairies, cordgrass flats, and scrub-live oak; further inland on prairies, mesquite and oak savannas, and mixed savanna-chaparral; breeding March-May

Wood Stork	*Mycteria americana*		T

forages in prairie ponds, flooded pastures or fields, ditches, and other shallow standing water, including salt-water; usually roosts communally in tall snags, sometimes in association with other wading birds (i.e. active heronries); breeds in Mexico and birds move into Gulf States in search of mud flats and other wetlands, even those associated with forested areas; formerly nested in Texas, but no breeding records since 1960

INSECTS

		Federal Status	State Status
Los Olmos tiger beetle	*Cicindela nevadica olmosa*		

most tiger beetles are active, usually brightly colored, and found in open, sunny areas; adult tiger beetles are predaceous and feed on a variety of small insects; larvae of tiger beetles are also predaceous and live in vertical burrows in soil of dry paths, fields, or sandy beaches

Superb grasshopper	*Eximacris superbum*		

collected in south Texas, but repeated efforts to collect not successful; may over-winter in adult stage

BROOKS COUNTY

MAMMALS

		Federal Status	State Status
Jaguar	*Panthera onca*	LE	E

extirpated; dense chaparral; no reliable TX sightings since 1952

Jaguarundi	*Herpailurus yaguarondi*	LE	E

thick brushlands, near water favored; 60 to 75 day gestation, young born sometimes twice per year in March and August, elsewhere the beginning of the rainy season and end of the dry season

Ocelot	*Leopardus pardalis*	LE	E

dense chaparral thickets; mesquite-thorn scrub and live oak mottes; avoids open areas; breeds and raises young June-November

Plains spotted skunk	*Spilogale putorius interrupta*		

catholic; open fields, prairies, croplands, fence rows, farmyards, forest edges, and woodlands; prefers wooded, brushy areas and tallgrass prairie

Southern yellow bat	*Lasiurus ega*		T

associated with trees, such as palm trees (Sabal mexicana) in Brownsville, which provide them with daytime roosts; insectivorous; breeding in late winter

White-nosed coati	*Nasua narica*		T

woodlands, riparian corridors and canyons; most individuals in Texas probably transients from Mexico; diurnal and crepuscular; very sociable; forages on ground and in trees; omnivorous; may be susceptible to hunting, trapping, and pet trade

REPTILES

		Federal Status	State Status
Keeled earless lizard	*Holbrookia propinqua*		

coastal dunes, barrier islands, and other sandy areas; eats insects and likely other small invertebrates; eggs laid underground March-September (most May-August)

Northern cat-eyed snake	*Leptodeira septentrionalis septentrionalis*		T

Gulf Coastal Plain south of the Nueces River; thorn brush woodland; dense thickets bordering ponds and streams; semi-arboreal; nocturnal

Spot-tailed earless lizard	*Holbrookia lacerata*		

central and southern Texas and adjacent Mexico; moderately open prairie-brushland; fairly flat areas free of vegetation or other obstructions, including disturbed areas; eats small invertebrates; eggs laid underground

Texas horned lizard	*Phrynosoma cornutum*		T

open, arid and semi-arid regions with sparse vegetation, including grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive; breeds March-September

BROOKS COUNTY

REPTILES

		Federal Status	State Status
Texas indigo snake	*Drymarchon melanurus erebennus*		T

Texas south of the Guadalupe River and Balcones Escarpment; thornbush-chaparral woodlands of south Texas, in particular dense riparian corridors; can do well in suburban and irrigated croplands if not molested or indirectly poisoned; requires moist microhabitats, such as rodent burrows, for shelter

Texas scarlet snake	*Cemophora coccinea lineri*		T

mixed hardwood scrub on sandy soils; feeds on reptile eggs; semi-fossorial; active April-September

Texas tortoise	*Gopherus berlandieri*		T

open brush with a grass understory is preferred; open grass and bare ground are avoided; when inactive occupies shallow depressions at base of bush or cactus, sometimes in underground burrows or under objects; longevity greater than 50 years; active March-November; breeds April-November

PLANTS

		Federal Status	State Status
Amelia's abronia	*Abronia ameliae*		

Endemic to South Texas; Occurs on deep, well-drained sandy soils of the South Texas Sand Sheet in grassy and/or herbaceous dominated openings within coastal live oak woodlands or mesquite-coastal live oak woodlands. Perennial; Flowering Mar-June

Bailey's ballmoss *Tillandsia baileyi*

epiphytic on various trees and tall shrubs, perhaps most common in mottes of Live oak on vegtated dunes and flats in coastal portions of the South Texas Sand Sheet, but also on evergreen sub-tropical woodlands along resacas in the Lower Rio Grande Valley; flowering (February-)April-May, but conspicuous throughout the year

Bristle nailwort *Paronychia setacea*

Flowering vascular plant endemic to eastern southcentral Texas, occurring in sandy soils

Burridge greenthread *Thelesperma burridgeanum*

GLOBAL RANK: G3; Sandy open areas; Annual; Flowering March-Nov; Fruiting March-June

Cory's croton *Croton coryi*

GLOBAL RANK: G3; Grasslands and woodland openings on barrier islands and coastal sands of South Texas, inland on South Texas Sand Sheet; Annual; Flowering July-Oct; Fruiting July-Nov

Falfurrias milkvine *Matelea radiata*

Texas endemic; uncertain, only two known specimens; one from clay soil on dry gravel hills at altitude of approximately 45 m (150 ft); other from Falfurrias, no habitat description; probably flowering May-June

Jones' nailwort *Paronychia jonesii*

GLOBAL RANK: G3; Occurs in early successional open areas on deep well-drained sand; Biennial Annual; Flowering March-Nov; Fruiting April-Nov

Sand Brazos mint *Brazoria arenaria*

GLOBAL RANK: G3; Sandy areas in South Texas; Annual; Flowering/Fruiting March-April

BROOKS COUNTY

PLANTS		Federal Status	State Status
Sand sheet leaf-flower	*Phyllanthus abnormis var. riograndensis*		

GLOBAL RANK: G5T3; Semi-desert scrub of deep South Texas; Annual; Flowering Feb-July; Fruiting Oct-March

Shortcrown milkvine *Matelea brevicoronata*

GLOBAL RANK: G3; Primarily in grasslands on tight sandy or silty substrates; Perennial; Flowering March-Sept; Fruiting May-Sept

South Texas gilia *Gilia ludens*

GLOBAL RANK: G3; Occurs in open areas in shrublands on shallow sandy loam over rock outcrops; Perennial; Flowering Dec-April; Fruiting March

Stinking rushpea *Pomaria austrotexana*

GLOBAL RANK: G3; In open areas on deep well drained sands; Perennial; Flowering Feb-Oct; Fruiting April-Oct

Texas peachbush *Prunus texana*

GLOBAL RANK: G3; Occurs at scattered sites in various well drained sandy situations; deep sand, plains and sand hills, grasslands, oak woods, 0-200 m elevation; Perennial; Flowering Feb-Mar; Fruiting Apr-Jun

Texas stonecrop *Lenophyllum texanum*

GLOBAL RANK: G3; Found in shrublands on clay dunes (lomas) at the mouth of the Rio Grande and on xeric calcareous rock outcrops at scattered inland sites; Perennial; Flowering/Fruiting Nov-Feb

Velvet spurge *Euphorbia innocua*

GLOBAL RANK: G3; Open or brushy areas on coastal sands and the South Texas Sand Sheet; Perennial; Flowering Sept-April; Fruiting Nov-July

Wright's trichocoronis *Trichocoronis wrightii var. wrightii*

GLOBAL RANK: G4T3; Most records from Texas are historical, perhaps indicating a decline as a result of alteration of wetland habitats; Annual; Flowering Feb-Oct; Fruiting Feb-Sept

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CAMERON COUNTY

AMPHIBIANS

		Federal Status	State Status
Black-spotted newt	*Notophthalmus meridionalis*		T

can be found in wet or sometimes wet areas, such as arroyos, canals, ditches, or even shallow depressions; aestivates in the ground during dry periods; Gulf Coastal Plain south of the San Antonio River

Mexican treefrog	*Smilisca baudinii*		T

subtropical region of extreme southern Texas; breeds May-October coinciding with rainfall, eggs laid in temporary rain pools

Sheep frog	*Hypopachus variolosus*		T

predominantly grassland and savanna; moist sites in arid areas

South Texas siren (large form)	*Siren sp 1*		T

wet or sometimes wet areas, such as arroyos, canals, ditches, or even shallow depressions; aestivates in the ground during dry periods, but does require some moisture to remain; southern Texas south of Balcones Escarpment; breeds February-June

White-lipped frog	*Leptodactylus fragilis*		T

grasslands, cultivated fields, roadside ditches, and a wide variety of other habitats; often hides under rocks or in burrows under clumps of grass; species requirements incompatible with widespread habitat alteration and pesticide use in south Texas

BIRDS

		Federal Status	State Status
American Peregrine Falcon	*Falco peregrinus anatum*	DL	T

year-round resident and local breeder in west Texas, nests in tall cliff eyries; also, migrant across state from more northern breeding areas in US and Canada, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.

Arctic Peregrine Falcon	*Falco peregrinus tundrius*	DL	

migrant throughout state from subspecies' far northern breeding range, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.

Audubon's Oriole	*Icterus graduacauda audubonii*		

scrub, mesquite; nests in dense trees, or thickets, usually along water courses

Brown Pelican	*Pelecanus occidentalis*	DL	

largely coastal and near shore areas, where it roosts and nests on islands and spoil banks

Brownsville Common Yellowthroat	*Geothlypis trichas insperata*		

tall grasses and bushes near ponds, marshes, and swamps; breeding April to July

CAMERON COUNTY

BIRDS		Federal Status	State Status
Cactus Ferruginous Pygmy-Owl	*Glaucidium brasilianum cactorum*		T

riparian trees, brush, palm, and mesquite thickets; during day also roosts in small caves and recesses on slopes of low hills; breeding April to June

Common Black-Hawk	*Buteogallus anthracinus*		T

cottonwood-lined rivers and streams; willow tree groves on the lower Rio Grande floodplain; formerly bred in south Texas

Eskimo Curlew	*Numenius borealis*	LE	E

historic; nonbreeding: grasslands, pastures, plowed fields, and less frequently, marshes and mudflats

Gray Hawk	*Asturina nitida*		T

locally and irregularly along U.S.-Mexico border; mature riparian woodlands and nearby semiarid mesquite and scrub grasslands; breeding range formerly extended north to southernmost Rio Grande floodplain of Texas

Interior Least Tern	*Sterna antillarum athalassos*	LE	E

subspecies is listed only when inland (more than 50 miles from a coastline); nests along sand and gravel bars within braided streams, rivers; also know to nest on man-made structures (inland beaches, wastewater treatment plants, gravel mines, etc); eats small fish and crustaceans, when breeding forages within a few hundred feet of colony

Northern Aplomado Falcon	*Falco femoralis septentrionalis*	LE	E

open country, especially savanna and open woodland, and sometimes in very barren areas; grassy plains and valleys with scattered mesquite, yucca, and cactus; nests in old stick nests of other bird species

Northern Beardless-Tyrannulet	*Camptostoma imberbe*		T

mesquite woodlands; near Rio Grande frequents cottonwood, willow, elm, and great leadtree; breeding April to July

Peregrine Falcon	*Falco peregrinus*	DL	T

both subspecies migrate across the state from more northern breeding areas in US and Canada to winter along coast and farther south; subspecies (F. p. anatum) is also a resident breeder in west Texas; the two subspecies' listing statuses differ, F.p. tundrius is no longer listed in Texas; but because the subspecies are not easily distinguishable at a distance, reference is generally made only to the species level; see subspecies for habitat.

Piping Plover	*Charadrius melodus*	LT	T

wintering migrant along the Texas Gulf Coast; beaches and bayside mud or salt flats

Red Knot	*Calidris canutus rufa*	T	

CAMERON COUNTY

BIRDS		Federal Status	State Status

Red knots migrate long distances in flocks northward through the contiguous United States mainly April-June, southward July-October. A small plump-bodied, short-necked shorebird that in breeding plumage, typically held from May through August, is a distinctive and unique pottery orange color. Its bill is dark, straight and, relative to other shorebirds, short-to-medium in length. After molting in late summer, this species is in a drab gray-and-white non-breeding plumage, typically held from September through April. In the non-breeding plumage, the knot might be confused with the omnipresent Sanderling. During this plumage, look for the knot’s prominent pale eyebrow and whitish flanks with dark barring. The Red Knot prefers the shoreline of coast and bays and also uses mudflats during rare inland encounters. Primary prey items include coquina clam (Donax spp.) on beaches and dwarf surf clam (Mulinia lateralis) in bays, at least in the Laguna Madre. Wintering Range includes- Aransas, Brazoria, Calhoun, Cameron, Chambers, Galveston, Jefferson, Kennedy, Kleberg, Matagorda, Nueces, San Patricio, and Willacy. Habitat: Primarily seacoasts on tidal flats and beaches, herbaceous wetland, and Tidal flat/shore.

Reddish Egret *Egretta rufescens* T

resident of the Texas Gulf Coast; brackish marshes and shallow salt ponds and tidal flats; nests on ground or in trees or bushes, on dry coastal islands in brushy thickets of yucca and prickly pear

Rose-throated Becard *Pachyramphus aglaiae* T

riparian trees, woodlands, open forest, scrub, and mangroves; breeding April to July

Sennett's Hooded Oriole *Icterus cucullatus sennetti*

often builds nests in and of Spanish moss (Tillandsia unioides); feeds on invertebrates, fruit, and nectar; breeding March to August

Snowy Plover *Charadrius alexandrinus*

formerly an uncommon breeder in the Panhandle; potential migrant; winter along coast

Sooty Tern *Sterna fuscata* T

predominately 'on the wing'; does not dive, but snatches small fish and squid with bill as it flies or hovers over water; breeding April-July

Sprague's Pipit *Anthus spragueii*

only in Texas during migration and winter, mid September to early April; short to medium distance, diurnal migrant; strongly tied to native upland prairie, can be locally common in coastal grasslands, uncommon to rare further west; sensitive to patch size and avoids edges.

Texas Botteri's Sparrow *Aimophila botterii texana* T

grassland and short-grass plains with scattered bushes or shrubs, sagebrush, mesquite, or yucca; nests on ground of low clump of grasses

Tropical Parula *Parula pitiayumi* T

dense or open woods, undergrowth, brush, and trees along edges of rivers and resacas; breeding April to July

Western Burrowing Owl *Athene cunicularia hypugaea*

open grasslands, especially prairie, plains, and savanna, sometimes in open areas such as vacant lots near human habitation or airports; nests and roosts in abandoned burrows

CAMERON COUNTY

BIRDS		Federal Status	State Status
Western Snowy Plover	*Charadrius alexandrinus nivosus*		

uncommon breeder in the Panhandle; potential migrant; winter along coast

White-faced Ibis	*Plegadis chihi*		T

prefers freshwater marshes, sloughs, and irrigated rice fields, but will attend brackish and saltwater habitats; nests in marshes, in low trees, on the ground in bulrushes or reeds, or on floating mats

White-tailed Hawk	*Buteo albicaudatus*		T

near coast on prairies, cordgrass flats, and scrub-live oak; further inland on prairies, mesquite and oak savannas, and mixed savanna-chaparral; breeding March-May

Wood Stork	*Mycteria americana*		T

forages in prairie ponds, flooded pastures or fields, ditches, and other shallow standing water, including salt-water; usually roosts communally in tall snags, sometimes in association with other wading birds (i.e. active heronries); breeds in Mexico and birds move into Gulf States in search of mud flats and other wetlands, even those associated with forested areas; formerly nested in Texas, but no breeding records since 1960

Zone-tailed Hawk	*Buteo albonotatus*		T

arid open country, including open deciduous or pine-oak woodland, mesa or mountain county, often near watercourses, and wooded canyons and tree-lined rivers along middle-slopes of desert mountains; nests in various habitats and sites, ranging from small trees in lower desert, giant cottonwoods in riparian areas, to mature conifers in high mountain regions

FISHES		Federal Status	State Status
American eel	*Anguilla rostrata*		

coastal waterways below reservoirs to gulf; spawns January to February in ocean, larva move to coastal waters, metamorphose, then females move into freshwater; most aquatic habitats with access to ocean, muddy bottoms, still waters, large streams, lakes; can travel overland in wet areas; males in brackish estuaries; diet varies widely, geographically, and seasonally

Mexican goby	*Ctenogobius claytonii*		T

Southern coastal area; brackish and freshwater coastal streams

Opossum pipefish	*Microphis brachyurus*		T

brooding adults found in fresh or low salinity waters and young move or are carried into more saline waters after birth; southern coastal areas

Rio Grande shiner	*Notropis jemezanus*		

Rio Grande and upper Pecos River basins; large, open, weedless rivers or large creeks with bottom of rubble, gravel and sand, often overlain with silt

CAMERON COUNTY

FISHES

		Federal Status	State Status
Rio Grande silvery minnow	*Hybognathus amarus*	LE	E

extirpated; historically Rio Grande and Pecos River systems and canals; reintroduced in Big Bend area; pools and backwaters of medium to large streams with low or moderate gradient in mud, sand, or gravel bottom; ingests mud and bottom ooze for algae and other organic matter; probably spawns on silt substrates of quiet coves

River goby	*Awaous banana*		T

Southern coastal waters; clear water with slow to moderate current, sandy or hard bottom, and little or no vegetation; also enters brackish and ocean waters

Smalltooth sawfish	*Pristis pectinata*	LE	E

different life history stages have different patterns of habitat use; young found very close to shore in muddy and sandy bottoms, seldom descending to depths greater than 32 ft (10 m); in sheltered bays, on shallow banks, and in estuaries or river mouths; adult sawfish are encountered in various habitat types (mangrove, reef, seagrass, and coral), in varying salinity regimes and temperatures, and at various water depths, feed on a variety of fish species and crustaceans

INSECTS

		Federal Status	State Status
A Royal moth	*Sphingicampa blanchardi*		

woodland - hardwood; Tamaulipan thornscrub with caterpillar's host plant, Texas Ebony (Pitheocellobium flexicaule) an important element

Manfreda giant-skipper	*Stallingsia maculosus*		

most skippers are small and stout-bodied; name derives from fast, erratic flight; at rest most skippers hold front and hind wings at different angles; skipper larvae are smooth, with the head and neck constricted; skipper larvae usually feed inside a leaf shelter and pupate in a cocoon made of leaves fastened together with silk

Smyth's tiger beetle	*Cicindela chlorocephala smythi*		

most tiger beetles are active, usually brightly colored, and found in open, sunny areas; adult tiger beetles are predaceous and feed on a variety of small insects; larvae of tiger beetles are also predaceous and live in vertical burrows in soil of dry paths, fields, or sandy beaches

Subtropical blue-black tiger beetle	*Cicindela nigrocoerulea subtropica*		

most tiger beetles are active, usually brightly colored, and found in open, sunny areas; adult tiger beetles are predaceous and feed on a variety of small insects; larvae of tiger beetles are also predaceous and live in vertical burrows in soil of dry paths, fields, or sandy beaches

Tamaulipan agapema	*Agapema galbina*		

Tamaulipan thornscrub with adequate densities of the caterpillar foodplant Condalia hookeri hookeri (= obovata); adults occur Sep - Oct; eggs hatch within two weeks and larvae mature 'rapidly'

CAMERON COUNTY

MAMMALS

		Federal Status	State Status
Coues' rice rat	*Oryzomys couesi*		T

cattail-bulrush marsh with shallower zone of aquatic grasses near the shoreline; shade trees around the shoreline are important features; prefers salt and freshwater, as well as grassy areas near water; breeds April-August

Jaguar	*Panthera onca*	LE	E

extirpated; dense chaparral; no reliable TX sightings since 1952

Jaguarundi	*Herpailurus yaguarondi*	LE	E

thick brushlands, near water favored; 60 to 75 day gestation, young born sometimes twice per year in March and August, elsewhere the beginning of the rainy season and end of the dry season

Mexican long-tongued bat	*Choeronycteris mexicana*		

deep canyons where uses caves and mine tunnels as day roosts; also found in buildings and often associated with big-eared bats (Plecotus spp.); single TX record from Santa Ana NWR

Ocelot	*Leopardus pardalis*	LE	E

dense chaparral thickets; mesquite-thorn scrub and live oak mottes; avoids open areas; breeds and raises young June-November

Plains spotted skunk	*Spilogale putorius interrupta*		

catholic; open fields, prairies, croplands, fence rows, farmyards, forest edges, and woodlands; prefers wooded, brushy areas and tallgrass prairie

Southern yellow bat	*Lasiurus ega*		T

associated with trees, such as palm trees (Sabal mexicana) in Brownsville, which provide them with daytime roosts; insectivorous; breeding in late winter

West Indian manatee	*Trichechus manatus*	LE	E

Gulf and bay system; opportunistic, aquatic herbivore

White-nosed coati	*Nasua narica*		T

woodlands, riparian corridors and canyons; most individuals in Texas probably transients from Mexico; diurnal and crepuscular; very sociable; forages on ground and in trees; omnivorous; may be susceptible to hunting, trapping, and pet trade

MOLLUSKS

		Federal Status	State Status
Mexican fawnsfoot mussel	*Truncilla cognata*		T

largely unknown; possibly intolerant of impoundment; possibly needs flowing streams and rivers with sand or gravel bottoms based on related species needs; Rio Grande basin

Salina mucket	*Potamilus metnecktayi*		T

lotic waters; submerged soft sediment (clay and silt) along river bank; other habitat requirements are poorly understood; Rio Grande Basin

CAMERON COUNTY

MOLLUSKS		Federal Status	State Status
Texas hornshell	*Popenaias popeii*	C	T

both ends of narrow shallow runs over bedrock, in areas where small-grained materials collect in crevices, along river banks, and at the base of boulders; not known from impoundments; Rio Grande Basin and several rivers in Mexico

REPTILES		Federal Status	State Status
Atlantic hawksbill sea turtle	*Eretmochelys imbricata*	LE	E

Gulf and bay system, warm shallow waters especially in rocky marine environments, such as coral reefs and jetties, juveniles found in floating mats of sea plants; feed on sponges, jellyfish, sea urchins, molluscs, and crustaceans, nests April through November

Black-striped snake	*Coniophanes imperialis*		T

extreme south Texas; semi-arid coastal plain, warm, moist micro-habitats and sandy soils; proficient burrower; eggs laid April-June

Green sea turtle	*Chelonia mydas*	LT	T

Gulf and bay system; shallow water seagrass beds, open water between feeding and nesting areas, barrier island beaches; adults are herbivorous feeding on sea grass and seaweed; juveniles are omnivorous feeding initially on marine invertebrates, then increasingly on sea grasses and seaweeds; nesting behavior extends from March to October, with peak activity in May and June

Keeled earless lizard	*Holbrookia propinqua*		

coastal dunes, barrier islands, and other sandy areas; eats insects and likely other small invertebrates; eggs laid underground March-September (most May-August)

Kemp's Ridley sea turtle	*Lepidochelys kempii*	LE	E

Gulf and bay system, adults stay within the shallow waters of the Gulf of Mexico; feed primarily on crabs, but also snails, clams, other crustaceans and plants, juveniles feed on sargassum and its associated fauna; nests April through August

Leatherback sea turtle	*Dermochelys coriacea*	LE	E

Gulf and bay systems, and widest ranging open water reptile; omnivorous, shows a preference for jellyfish; in the US portion of their western Atlantic nesting territories, nesting season ranges from March to August

Loggerhead sea turtle	*Caretta caretta*	LT	T

Gulf and bay system primarily for juveniles, adults are most pelagic of the sea turtles; omnivorous, shows a preference for mollusks, crustaceans, and coral; nests from April through November

Northern cat-eyed snake	*Leptodeira septentrionalis septentrionalis*		T

Gulf Coastal Plain south of the Nueces River; thorn brush woodland; dense thickets bordering ponds and streams; semi-arboreal; nocturnal

Speckled racer	*Drymobius margaritiferus*		T

extreme south Texas; dense thickets near water, Texas palm groves, riparian woodlands; often in areas with much vegetation litter on ground; breeds April-August

CAMERON COUNTY

REPTILES		Federal Status	State Status
Texas horned lizard	*Phrynosoma cornutum*		T

open, arid and semi-arid regions with sparse vegetation, including grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive; breeds March-September

Texas indigo snake	*Drymarchon melanurus erebennus*		T

Texas south of the Guadalupe River and Balcones Escarpment; thornbush-chaparral woodlands of south Texas, in particular dense riparian corridors; can do well in suburban and irrigated croplands if not molested or indirectly poisoned; requires moist microhabitats, such as rodent burrows, for shelter

Texas scarlet snake	*Cemophora coccinea lineri*		T

mixed hardwood scrub on sandy soils; feeds on reptile eggs; semi-fossorial; active April-September

Texas tortoise	*Gopherus berlandieri*		T

open brush with a grass understory is preferred; open grass and bare ground are avoided; when inactive occupies shallow depressions at base of bush or cactus, sometimes in underground burrows or under objects; longevity greater than 50 years; active March-November; breeds April-November

PLANTS		Federal Status	State Status
Bailey's ballmoss	*Tillandsia baileyi*		

epiphytic on various trees and tall shrubs, perhaps most common in mottes of Live oak on vegtated dunes and flats in coastal portions of the South Texas Sand Sheet, but also on evergreen sub-tropical woodlands along resacas in the Lower Rio Grande Valley; flowering (February-)April-May, but conspicuous throughout the year

Buckley's spiderwort	*Tradescantia buckleyi*		

Occurs on sandy loam or clay soils in grasslands or shrublands underlain by the Beaumount Formation.

Green Island echeandia	*Echeandia texensis*		

on somewhat saline clays of lomas along the Gulf Coast near the mouth of Rio Grande, a habitat shared with E. chandleri; both species grow in areas dominated by herbaceous species with scattered brush and stunted trees, or in grassy openings in subtropical thorn shrublands; flowers April, June, and November, and likely in other months, as well

Large selenia	*Selenia grandis*		

GLOBAL RANK: G4; Occurs in seasonally wet clayey soils in open areas; Annual; Flowering Jan-April; Fruiting Feb-April

Lila de los llanos	*Echeandia chandleri*		

most commonly encountered among shrubs or in grassy openings in subtropical thorn shrublands on somewhat saline clays of lomas along Gulf Coast near mouth of Rio Grande; also observed in a few upland coastal prairie remnants on clay soils over the Beaumont Formation at inland sites well to the north and along railroad right-of-ways and cemeteries; flowering (May-) September-December, fruiting October-December

CAMERON COUNTY

PLANTS		Federal Status	State Status

Marsh-elder dodder *Cuscuta attenuata*

GLOBAL RANK: G1G3; Parasitizes a particular sumpweed (Iva annua) almost exclusively as well as ragweed and heath aster. Host plants typically found in open, disturbed habitats like fallow fields and creek bottomlands; Annual; Flowering late summer through October

Mexican mud-plantain *Heteranthera mexicana*

wet clayey soils of resacas and ephemeral wetlands in South Texas and along margins of playas in the Panhandle; flowering June-December, only after sufficient rainfall

Plains gumweed *Grindelia oolepis*

coastal prairies on heavy clay (blackland) soils, often in depressional areas, sometimes persisting in areas where management (mowing) may maintain or mimic natural prairie disturbance regimes; 'crawfish lands'; on nearly level Victoria clay, Edroy clay, claypan, possibly Greta within Orelia fine sandy loam over the Beaumont Formation, and Harlingen clay; roadsides, railroad rights-of-ways, vacant lots in urban areas, cemeteries; flowering April-December

Runyon's cory cactus *Coryphantha macromeris var runyonii*

gravelly to sandy or clayey, calcareous, sometimes gypsiferous or saline soils, often over the Catahoula and Frio formations, on gentle hills and slopes to the flats between, at elevations ranging from 10 to 150 m (30 to 500 ft); ?late spring or early summer, November, fruit has been collected in August

Runyon's water-willow *Justicia runyonii*

margins of and openings within subtropical woodlands or thorn shrublands on calcareous, alluvial, silty or clayey soils derived from Holocene silt and sand floodplain deposits of the Rio Grande Delta; can be common in narow openings such as those provided by trails through dense ebony woodlands and is sometimes restricted to microdepressions; flowering (July-) September-November

Shinners' rocket *Thelypodiopsis shinnersii*

mostly along margins of Tamaulipan thornscrub on clay soils of the Rio Grande Delta, including lomas near the mouth of the river; Tamaulipas, Mexico specimens are from mountains, with no further detail; flowering mostly March-April, with one collection in December

Siler's huaco *Manfreda sileri*

GLOBAL RANK: G3; Rare in a variety of grasslands and shrublands on dry sites; Perennial; Flowering April-July; Fruiting June-July

South Texas ambrosia	*Ambrosia cheiranthifolia*	LE	E

Grasslands and mesquite-dominated shrublands on various soils ranging from heavy clays to lighter textured sandy loams, mostly over the Beaumont Formation on the Coastal Plain; in modified unplowed sites such as railroad and highyway right-of-ways, cemeteries, mowed fields, erosional areas along small creeks; Perennial; Flowering July-November

South Texas spikesedge *Eleocharis austrotexana*

GLOBAL RANK: G3; Occurring in miscellaneous wetlands at scattered locations on the coastal plain; Perennial; Flowering/Fruiting Sept

Star cactus	*Astrophytum asterias*	LE	E

CAMERON COUNTY

PLANTS		Federal Status	State Status

gravelly clays or loams, possibly of the Catarina Series (deep, droughty, saline clays), over the Catahoula and Frio formations, on gentle slopes and flats in sparsely vegetated openings between shrub thickets within mesquite grasslands or mesquite-blackbrush thorn shrublands; plants sink into or below ground during dry periods; flowering from mid March-May, may also flower in warmer months after sufficient rainfall, flowers most reliably in early April; fruiting mid April-June

Texas ayenia	*Ayenia limitaris*	LE	E

Subtropical thorn woodland or tall shrubland on loamy soils of the Rio Grande Delta; known site soils include well-drained, calcareous, sandy clay loam (Hidalgo Series) and neutral to moderately alkaline, fine sandy loam (Willacy Series); also under or among taller shrubs in thorn woodland/thorn shrubland; flowering throughout the year with sufficient rainfall

Texas milk vetch *Astragalus reflexus*

GLOBAL RANK: G3; Grasslands, prairies, and roadsides on calcareous and clay substrates; Annual; Flowering Feb-June; Fruiting April-June

Texas stonecrop *Lenophyllum texanum*

GLOBAL RANK: G3; Found in shrublands on clay dunes (lomas) at the mouth of the Rio Grande and on xeric calcareous rock outcrops at scattered inland sites; Perennial; Flowering/Fruiting Nov-Feb

Vasey's adelia *Adelia vaseyi*

Mostly subtropical evergreen/deciduous woodlands on loamy soils of Rio Grande Delta, but occassionally in shrublands on more xeric sandy to gravelly upland sites; Perennial; Flowering January-June

Wright's trichocoronis *Trichocoronis wrightii var. wrightii*

GLOBAL RANK: G4T3; Most records from Texas are historical, perhaps indicating a decline as a result of alteration of wetland habitats; Annual; Flowering Feb-Oct; Fruiting Feb-Sept

Yellow-flowered alicoche *Echinocereus papillosus*

GLOBAL RANK: G3; Under shrubs or in open areas on various substrates; Perennial; Flowering Jan-April

HIDALGO COUNTY

AMPHIBIANS		Federal Status	State Status
Black-spotted newt	*Notophthalmus meridionalis*		T

can be found in wet or sometimes wet areas, such as arroyos, canals, ditches, or even shallow depressions; aestivates in the ground during dry periods; Gulf Coastal Plain south of the San Antonio River

Mexican treefrog	*Smilisca baudinii*		T

subtropical region of extreme southern Texas; breeds May-October coinciding with rainfall, eggs laid in temporary rain pools

Sheep frog	*Hypopachus variolosus*		T

predominantly grassland and savanna; moist sites in arid areas

South Texas siren (large form)	*Siren sp 1*		T

wet or sometimes wet areas, such as arroyos, canals, ditches, or even shallow depressions; aestivates in the ground during dry periods, but does require some moisture to remain; southern Texas south of Balcones Escarpment; breeds February-June

White-lipped frog	*Leptodactylus fragilis*		T

grasslands, cultivated fields, roadside ditches, and a wide variety of other habitats; often hides under rocks or in burrows under clumps of grass; species requirements incompatible with widespread habitat alteration and pesticide use in south Texas

BIRDS		Federal Status	State Status
American Peregrine Falcon	*Falco peregrinus anatum*	DL	T

year-round resident and local breeder in west Texas, nests in tall cliff eyries; also, migrant across state from more northern breeding areas in US and Canada, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.

Arctic Peregrine Falcon	*Falco peregrinus tundrius*	DL	

migrant throughout state from subspecies’ far northern breeding range, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.

Audubon's Oriole	*Icterus graduacauda audubonii*		

scrub, mesquite; nests in dense trees, or thickets, usually along water courses

Brownsville Common Yellowthroat	*Geothlypis trichas insperata*		

tall grasses and bushes near ponds, marshes, and swamps; breeding April to July

HIDALGO COUNTY

BIRDS		Federal Status	State Status
Cactus Ferruginous Pygmy-Owl	*Glaucidium brasilianum cactorum*		T

riparian trees, brush, palm, and mesquite thickets; during day also roosts in small caves and recesses on slopes of low hills; breeding April to June

Common Black-Hawk	*Buteogallus anthracinus*		T

cottonwood-lined rivers and streams; willow tree groves on the lower Rio Grande floodplain; formerly bred in south Texas

Gray Hawk	*Asturina nitida*		T

locally and irregularly along U.S.-Mexico border; mature riparian woodlands and nearby semiarid mesquite and scrub grasslands; breeding range formerly extended north to southernmost Rio Grande floodplain of Texas

Hook-billed Kite	*Chondrohierax uncinatus*		

dense tropical and subtropical forests, but does occur in open woodlands; uncommon to rare in most of range; accidental in south Texas

Interior Least Tern	*Sterna antillarum athalassos*	LE	E

subspecies is listed only when inland (more than 50 miles from a coastline); nests along sand and gravel bars within braided streams, rivers; also know to nest on man-made structures (inland beaches, wastewater treatment plants, gravel mines, etc); eats small fish and crustaceans, when breeding forages within a few hundred feet of colony

Mountain Plover	*Charadrius montanus*		

breeding: nests on high plains or shortgrass prairie, on ground in shallow depression; nonbreeding: shortgrass plains and bare, dirt (plowed) fields; primarily insectivorous

Northern Aplomado Falcon	*Falco femoralis septentrionalis*	LE	E

open country, especially savanna and open woodland, and sometimes in very barren areas; grassy plains and valleys with scattered mesquite, yucca, and cactus; nests in old stick nests of other bird species

Northern Beardless-Tyrannulet	*Camptostoma imberbe*		T

mesquite woodlands; near Rio Grande frequents cottonwood, willow, elm, and great leadtree; breeding April to July

Peregrine Falcon	*Falco peregrinus*	DL	T

both subspecies migrate across the state from more northern breeding areas in US and Canada to winter along coast and farther south; subspecies (F. p. anatum) is also a resident breeder in west Texas; the two subspecies' listing statuses differ, F.p. tundrius is no longer listed in Texas; but because the subspecies are not easily distinguishable at a distance, reference is generally made only to the species level; see subspecies for habitat.

Reddish Egret	*Egretta rufescens*		T

resident of the Texas Gulf Coast; brackish marshes and shallow salt ponds and tidal flats; nests on ground or in trees or bushes, on dry coastal islands in brushy thickets of yucca and prickly pear

HIDALGO COUNTY

BIRDS		Federal Status	State Status
Rose-throated Becard	*Pachyramphus aglaiae*		T

riparian trees, woodlands, open forest, scrub, and mangroves; breeding April to July

Sennett's Hooded Oriole	*Icterus cucullatus sennetti*		

often builds nests in and of Spanish moss (Tillandsia unioides); feeds on invertebrates, fruit, and nectar; breeding March to August

Sprague's Pipit	*Anthus spragueii*		

only in Texas during migration and winter, mid September to early April; short to medium distance, diurnal migrant; strongly tied to native upland prairie, can be locally common in coastal grasslands, uncommon to rare further west; sensitive to patch size and avoids edges.

Texas Botteri's Sparrow	*Aimophila botterii texana*		T

grassland and short-grass plains with scattered bushes or shrubs, sagebrush, mesquite, or yucca; nests on ground of low clump of grasses

Tropical Parula	*Parula pitiayumi*		T

dense or open woods, undergrowth, brush, and trees along edges of rivers and resacas; breeding April to July

Western Burrowing Owl	*Athene cunicularia hypugaea*		

open grasslands, especially prairie, plains, and savanna, sometimes in open areas such as vacant lots near human habitation or airports; nests and roosts in abandoned burrows

Western Snowy Plover	*Charadrius alexandrinus nivosus*		

uncommon breeder in the Panhandle; potential migrant; winter along coast

White-faced Ibis	*Plegadis chihi*		T

prefers freshwater marshes, sloughs, and irrigated rice fields, but will attend brackish and saltwater habitats; nests in marshes, in low trees, on the ground in bulrushes or reeds, or on floating mats

White-tailed Hawk	*Buteo albicaudatus*		T

near coast on prairies, cordgrass flats, and scrub-live oak; further inland on prairies, mesquite and oak savannas, and mixed savanna-chaparral; breeding March-May

Wood Stork	*Mycteria americana*		T

forages in prairie ponds, flooded pastures or fields, ditches, and other shallow standing water, including salt-water; usually roosts communally in tall snags, sometimes in association with other wading birds (i.e. active heronries); breeds in Mexico and birds move into Gulf States in search of mud flats and other wetlands, even those associated with forested areas; formerly nested in Texas, but no breeding records since 1960

Zone-tailed Hawk	*Buteo albonotatus*		T

arid open country, including open deciduous or pine-oak woodland, mesa or mountain county, often near watercourses, and wooded canyons and tree-lined rivers along middle-slopes of desert mountains; nests in various habitats and sites, ranging from small trees in lower desert, giant cottonwoods in riparian areas, to mature conifers in high mountain regions

HIDALGO COUNTY

FISHES Federal Status State Status

American eel *Anguilla rostrata*

coastal waterways below reservoirs to gulf; spawns January to February in ocean, larva move to coastal waters, metamorphose, then females move into freshwater; most aquatic habitats with access to ocean, muddy bottoms, still waters, large streams, lakes; can travel overland in wet areas; males in brackish estuaries; diet varies widely, geographically, and seasonally

Rio Grande shiner *Notropis jemezanus*

Rio Grande and upper Pecos River basins; large, open, weedless rivers or large creeks with bottom of rubble, gravel and sand, often overlain with silt

Rio Grande silvery minnow *Hybognathus amarus* LE E

extirpated; historically Rio Grande and Pecos River systems and canals; reintroduced in Big Bend area; pools and backwaters of medium to large streams with low or moderate gradient in mud, sand, or gravel bottom; ingests mud and bottom ooze for algae and other organic matter; probably spawns on silt substrates of quiet coves

River goby *Awaous banana* T

Southern coastal waters; clear water with slow to moderate current, sandy or hard bottom, and little or no vegetation; also enters brackish and ocean waters

INSECTS Federal Status State Status

A mayfly *Campsurus decoloratus*

TX and MX; possibly clay substrates; mayflies distinguished by aquatic larval stage; adult stage generally found in shoreline vegetation

A Royal moth *Sphingicampa blanchardi*

woodland - hardwood; Tamaulipan thornscrub with caterpillar's host plant, Texas Ebony (Pitheocellobium flexicaule) an important element

A tiger beetle *Tetracha affinis angustata*

most tiger beetles diurnal, open sandy areas, beaches, open paths or lanes, or on mudflats; larvae in hard-packed ground in vertical burrows

Arroyo darner *Aeshna dugesi*

creek, high - moderate gradient; eggs laid in aquatic plants, larvae cling to bottom of pools of streams, adults forage widely in pools in streams, from desert up to pine-oak zone; invertivore, diurnal; larvae overwinter, flight season late June to early September

Los Olmos tiger beetle *Cicindela nevadica olmosa*

most tiger beetles are active, usually brightly colored, and found in open, sunny areas; adult tiger beetles are predaceous and feed on a variety of small insects; larvae of tiger beetles are also predaceous and live in vertical burrows in soil of dry paths, fields, or sandy beaches

HIDALGO COUNTY

INSECTS		Federal Status	State Status
Manfreda giant-skipper	*Stallingsia maculosus*		

most skippers are small and stout-bodied; name derives from fast, erratic flight; at rest most skippers hold front and hind wings at different angles; skipper larvae are smooth, with the head and neck constricted; skipper larvae usually feed inside a leaf shelter and pupate in a cocoon made of leaves fastened together with silk

Neojuvenile tiger beetle — *Cicindela obsoleta neojuvenilis*

bare or sparsely vegetated, dry, hard-packed soil; typically in previously disturbed areas; peak adult activity in Jul

Subtropical blue-black tiger beetle — *Cicindela nigrocoerulea subtropica*

most tiger beetles are active, usually brightly colored, and found in open, sunny areas; adult tiger beetles are predaceous and feed on a variety of small insects; larvae of tiger beetles are also predaceous and live in vertical burrows in soil of dry paths, fields, or sandy beaches

Tamaulipan agapema — *Agapema galbina*

Tamaulipan thornscrub with adequate densities of the caterpillar foodplant Condalia hookeri hookeri (= obovata); adults occur Sep - Oct; eggs hatch within two weeks and larvae mature 'rapidly'

MAMMALS		Federal Status	State Status
Cave myotis bat	*Myotis velifer*		

colonial and cave-dwelling; also roosts in rock crevices, old buildings, carports, under bridges, and even in abandoned Cliff Swallow (Hirundo pyrrhonota) nests; roosts in clusters of up to thousands of individuals; hibernates in limestone caves of Edwards Plateau and gypsum cave of Panhandle during winter; opportunistic insectivore

Coues' rice rat	*Oryzomys couesi*		T

cattail-bulrush marsh with shallower zone of aquatic grasses near the shoreline; shade trees around the shoreline are important features; prefers salt and freshwater, as well as grassy areas near water; breeds April-August

Jaguar	*Panthera onca*	LE	E

extirpated; dense chaparral; no reliable TX sightings since 1952

Jaguarundi	*Herpailurus yaguarondi*	LE	E

thick brushlands, near water favored; 60 to 75 day gestation, young born sometimes twice per year in March and August, elsewhere the beginning of the rainy season and end of the dry season

Mexican long-tongued bat — *Choeronycteris mexicana*

deep canyons where uses caves and mine tunnels as day roosts; also found in buildings and often associated with big-eared bats (Plecotus spp.); single TX record from Santa Ana NWR

Ocelot	*Leopardus pardalis*	LE	E

dense chaparral thickets; mesquite-thorn scrub and live oak mottes; avoids open areas; breeds and raises young June-November

HIDALGO COUNTY

MAMMALS		Federal Status	State Status
Plains spotted skunk	*Spilogale putorius interrupta*		

catholic; open fields, prairies, croplands, fence rows, farmyards, forest edges, and woodlands; prefers wooded, brushy areas and tallgrass prairie

Southern yellow bat	*Lasiurus ega*		T

associated with trees, such as palm trees (Sabal mexicana) in Brownsville, which provide them with daytime roosts; insectivorous; breeding in late winter

White-nosed coati	*Nasua narica*		T

woodlands, riparian corridors and canyons; most individuals in Texas probably transients from Mexico; diurnal and crepuscular; very sociable; forages on ground and in trees; omnivorous; may be susceptible to hunting, trapping, and pet trade

MOLLUSKS		Federal Status	State Status
Mexican fawnsfoot mussel	*Truncilla cognata*		T

largely unknown; possibly intolerant of impoundment; possibly needs flowing streams and rivers with sand or gravel bottoms based on related species needs; Rio Grande basin

Salina mucket	*Potamilus metnecktayi*		T

lotic waters; submerged soft sediment (clay and silt) along river bank; other habitat requirements are poorly understood; Rio Grande Basin

Texas hornshell	*Popenaias popeii*	C	T

both ends of narrow shallow runs over bedrock, in areas where small-grained materials collect in crevices, along river banks, and at the base of boulders; not known from impoundments; Rio Grande Basin and several rivers in Mexico

REPTILES		Federal Status	State Status
Black-striped snake	*Coniophanes imperialis*		T

extreme south Texas; semi-arid coastal plain, warm, moist micro-habitats and sandy soils; proficient burrower; eggs laid April-June

Northern cat-eyed snake	*Leptodeira septentrionalis septentrionalis*		T

Gulf Coastal Plain south of the Nueces River; thorn brush woodland; dense thickets bordering ponds and streams; semi-arboreal; nocturnal

Reticulate collared lizard	*Crotaphytus reticulatus*		T

requires open brush-grasslands; thorn-scrub vegetation, usually on well-drained rolling terrain of shallow gravel, caliche, or sandy soils; often on scattered flat rocks below escarpments or isolated rock outcrops among scattered clumps of prickly pear and mesquite

HIDALGO COUNTY

REPTILES

		Federal Status	State Status

Speckled racer — *Drymobius margaritiferus* — State Status: T

extreme south Texas; dense thickets near water, Texas palm groves, riparian woodlands; often in areas with much vegetation litter on ground; breeds April-August

Spot-tailed earless lizard — *Holbrookia lacerata*

central and southern Texas and adjacent Mexico; moderately open prairie-brushland; fairly flat areas free of vegetation or other obstructions, including disturbed areas; eats small invertebrates; eggs laid underground

Texas horned lizard — *Phrynosoma cornutum* — State Status: T

open, arid and semi-arid regions with sparse vegetation, including grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive; breeds March-September

Texas indigo snake — *Drymarchon melanurus erebennus* — State Status: T

Texas south of the Guadalupe River and Balcones Escarpment; thornbush-chaparral woodlands of south Texas, in particular dense riparian corridors; can do well in suburban and irrigated croplands if not molested or indirectly poisoned; requires moist microhabitats, such as rodent burrows, for shelter

Texas tortoise — *Gopherus berlandieri* — State Status: T

open brush with a grass understory is preferred; open grass and bare ground are avoided; when inactive occupies shallow depressions at base of bush or cactus, sometimes in underground burrows or under objects; longevity greater than 50 years; active March-November; breeds April-November

PLANTS

		Federal Status	State Status

Amelia's abronia — *Abronia ameliae*

Endemic to South Texas; Occurs on deep, well-drained sandy soils of the South Texas Sand Sheet in grassy and/or herbaceous dominated openings within coastal live oak woodlands or mesquite-coastal live oak woodlands. Perennial; Flowering Mar-June

Arrowleaf milkvine — *Matelea sagittifolia*

GLOBAL RANK: G3 ; Most consistently encountered in thornscrub in South Texas; Perennial; Flowering March-July; Fruiting April-July & Dec?

Bailey's ballmoss — *Tillandsia baileyi*

epiphytic on various trees and tall shrubs, perhaps most common in mottes of Live oak on vegtated dunes and flats in coastal portions of the South Texas Sand Sheet, but also on evergreen sub-tropical woodlands along resacas in the Lower Rio Grande Valley; flowering (February-)April-May, but conspicuous throughout the year

Chihuahua balloon-vine — *Cardiospermum dissectum*

Thorn shrublands or low woodlands on well to excessively well drained, calcareous, sandy to gravelly soils in drier uplands of the Lower Rio Grande Valley, in areas underlain by the Goliad formation, Catahoula and Frio formations undivided, Jackson Group, and other Eocene formations; during drought conditions the normally inconspicuous slender twining vine turns a more conspicuous deep reddish-purple; flowering (April-) July-September, probably throughout the growing season in response to rainfall.

HIDALGO COUNTY

PLANTS

Federal Status State Status

Cory's croton *Croton coryi*

GLOBAL RANK: G3; Grasslands and woodland openings on barrier islands and coastal sands of South Texas, inland on South Texas Sand Sheet; Annual; Flowering July-Oct; Fruiting July-Nov

Falfurrias milkvine *Matelea radiata*

Texas endemic; uncertain, only two known specimens; one from clay soil on dry gravel hills at altitude of approximately 45 m (150 ft); other from Falfurrias, no habitat description; probably flowering May-June

Gregg's wild-buckwheat *Eriogonum greggii*

sparingly vegetated openings in thorn shrublands in shallow soils on xeric ridges along the Rio Grande; also on excessively drained, sandy soil over caliche and calcareous sandstone of the Goliad Formation and over sandstone or fossiliferous layers of the Jackson Group; flowering February-July, probably opportunistically during the growing season

Jones' nailwort *Paronychia jonesii*

GLOBAL RANK: G3; Occurs in early successional open areas on deep well-drained sand; Biennial Annual; Flowering March-Nov; Fruiting April-Nov

Large selenia *Selenia grandis*

GLOBAL RANK: G4; Occurs in seasonally wet clayey soils in open areas; Annual; Flowering Jan-April; Fruiting Feb-April

Mexican mud-plantain *Heteranthera mexicana*

wet clayey soils of resacas and ephemeral wetlands in South Texas and along margins of playas in the Panhandle; flowering June-December, only after sufficient rainfall

Runyon's cory cactus *Coryphantha macromeris var runyonii*

gravelly to sandy or clayey, calcareous, sometimes gypsiferous or saline soils, often over the Catahoula and Frio formations, on gentle hills and slopes to the flats between, at elevations ranging from 10 to 150 m (30 to 500 ft); ?late spring or early summer, November, fruit has been collected in August

Runyon's water-willow *Justicia runyonii*

margins of and openings within subtropical woodlands or thorn shrublands on calcareous, alluvial, silty or clayey soils derived from Holocene silt and sand floodplain deposits of the Rio Grande Delta; can be common in narow openings such as those provided by trails through dense ebony woodlands and is sometimes restricted to microdepressions; flowering (July-) September-November

Sand Brazos mint *Brazoria arenaria*

GLOBAL RANK: G3; Sandy areas in South Texas; Annual; Flowering/Fruiting March-April

Sand sheet leaf-flower *Phyllanthus abnormis var. riograndensis*

GLOBAL RANK: G5T3; Semi-desert scrub of deep South Texas; Annual; Flowering Feb-July; Fruiting Oct-March

Shortcrown milkvine *Matelea brevicoronata*

GLOBAL RANK: G3; Primarily in grasslands on tight sandy or silty substrates; Perennial; Flowering March-Sept; Fruiting May-Sept

HIDALGO COUNTY

PLANTS

		Federal Status	State Status
Siler's huaco	*Manfreda sileri*		

GLOBAL RANK: G3; Rare in a variety of grasslands and shrublands on dry sites; Perennial; Flowering April-July; Fruiting June-July

Small-leaved yellow velvet-leaf	*Wissadula parvifolia*		

Occurs on sandy loams or clays in shrublands or woodlands on gently undulating terrain of the Holocene sand sheet over the Goliad Formation.

St. Joseph's staff	*Manfreda longiflora*		

thorn shrublands on clays and loams with various concentrations of salt, caliche, sand, and gravel; rossettes are often obscured by low shrubs; flowering September-October

Star cactus	*Astrophytum asterias*	LE	E

gravelly clays or loams, possibly of the Catarina Series (deep, droughty, saline clays), over the Catahoula and Frio formations, on gentle slopes and flats in sparsely vegetated openings between shrub thickets within mesquite grasslands or mesquite-blackbrush thorn shrublands; plants sink into or below ground during dry periods; flowering from mid March-May, may also flower in warmer months after sufficient rainfall, flowers most reliably in early April; fruiting mid April-June

Stinking rushpea	*Pomaria austrotexana*		

GLOBAL RANK: G3; In open areas on deep well drained sands; Perennial; Flowering Feb-Oct; Fruiting April-Oct

Texas ayenia	*Ayenia limitaris*	LE	E

Subtropical thorn woodland or tall shrubland on loamy soils of the Rio Grande Delta; known site soils include well-drained, calcareous, sandy clay loam (Hidalgo Series) and neutral to moderately alkaline, fine sandy loam (Willacy Series); also under or among taller shrubs in thorn woodland/thorn shrubland; flowering throughout the year with sufficient rainfall

Texas peachbush	*Prunus texana*		

GLOBAL RANK: G3; Occurs at scattered sites in various well drained sandy situations; deep sand, plains and sand hills, grasslands, oak woods, 0-200 m elevation; Perennial; Flowering Feb-Mar; Fruiting Apr-Jun

Texas stonecrop	*Lenophyllum texanum*		

GLOBAL RANK: G3; Found in shrublands on clay dunes (lomas) at the mouth of the Rio Grande and on xeric calcareous rock outcrops at scattered inland sites; Perennial; Flowering/Fruiting Nov-Feb

Vasey's adelia	*Adelia vaseyi*		

Mostly subtropical evergreen/deciduous woodlands on loamy soils of Rio Grande Delta, but occassionally in shrublands on more xeric sandy to gravelly upland sites; Perennial; Flowering January-June

Walker's manioc	*Manihot walkerae*	LE	E

periphery of native brush in sandy loam; also on caliche cuestas?; flowering April-September (following rains?)

HIDALGO COUNTY

PLANTS

Federal Status | State Status

Wright's trichocoronis *Trichocoronis wrightii var. wrightii*

GLOBAL RANK: G4T3; Most records from Texas are historical, perhaps indicating a decline as a result of alteration of wetland habitats; Annual; Flowering Feb-Oct; Fruiting Feb-Sept

Yellow-flowered alicoche *Echinocereus papillosus*

GLOBAL RANK: G3; Under shrubs or in open areas on various substrates; Perennial; Flowering Jan-April

JIM HOGG COUNTY

AMPHIBIANS

		Federal Status	State Status
Sheep frog	*Hypopachus variolosus*		T

predominantly grassland and savanna; moist sites in arid areas

BIRDS

		Federal Status	State Status
American Peregrine Falcon	*Falco peregrinus anatum*	DL	T

year-round resident and local breeder in west Texas, nests in tall cliff eyries; also, migrant across state from more northern breeding areas in US and Canada, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.

Arctic Peregrine Falcon	*Falco peregrinus tundrius*	DL	

migrant throughout state from subspecies' far northern breeding range, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.

Audubon's Oriole — *Icterus graduacauda audubonii*

scrub, mesquite; nests in dense trees, or thickets, usually along water courses

Mountain Plover — *Charadrius montanus*

breeding: nests on high plains or shortgrass prairie, on ground in shallow depression; nonbreeding: shortgrass plains and bare, dirt (plowed) fields; primarily insectivorous

Peregrine Falcon	*Falco peregrinus*	DL	T

both subspecies migrate across the state from more northern breeding areas in US and Canada to winter along coast and farther south; subspecies (F. p. anatum) is also a resident breeder in west Texas; the two subspecies' listing statuses differ, F.p. tundrius is no longer listed in Texas; but because the subspecies are not easily distinguishable at a distance, reference is generally made only to the species level; see subspecies for habitat.

Sennett's Hooded Oriole — *Icterus cucullatus sennetti*

often builds nests in and of Spanish moss (Tillandsia unioides); feeds on invertebrates, fruit, and nectar; breeding March to August

Sprague's Pipit — *Anthus spragueii*

only in Texas during migration and winter, mid September to early April; short to medium distance, diurnal migrant; strongly tied to native upland prairie, can be locally common in coastal grasslands, uncommon to rare further west; sensitive to patch size and avoids edges.

Western Burrowing Owl — *Athene cunicularia hypugaea*

open grasslands, especially prairie, plains, and savanna, sometimes in open areas such as vacant lots near human habitation or airports; nests and roosts in abandoned burrows

JIM HOGG COUNTY

BIRDS

Federal Status | State Status

Wood Stork *Mycteria americana* State Status: T

forages in prairie ponds, flooded pastures or fields, ditches, and other shallow standing water, including salt-water; usually roosts communally in tall snags, sometimes in association with other wading birds (i.e. active heronries); breeds in Mexico and birds move into Gulf States in search of mud flats and other wetlands, even those associated with forested areas; formerly nested in Texas, but no breeding records since 1960

INSECTS

Federal Status | State Status

Cazier's tiger beetle *Cicindela cazieri*

most tiger beetles are active, usually brightly colored, and found in open, sunny areas; adult tiger beetles are predaceous and feed on a variety of small insects; larvae of tiger beetles are also predaceous and live in vertical burrows in soil of dry paths, fields, or sandy beaches

Los Olmos tiger beetle *Cicindela nevadica olmosa*

most tiger beetles are active, usually brightly colored, and found in open, sunny areas; adult tiger beetles are predaceous and feed on a variety of small insects; larvae of tiger beetles are also predaceous and live in vertical burrows in soil of dry paths, fields, or sandy beaches

Superb grasshopper *Eximacris superbum*

collected in south Texas, but repeated efforts to collect not successful; may over-winter in adult stage

MAMMALS

Federal Status | State Status

Cave myotis bat *Myotis velifer*

colonial and cave-dwelling; also roosts in rock crevices, old buildings, carports, under bridges, and even in abandoned Cliff Swallow (Hirundo pyrrhonota) nests; roosts in clusters of up to thousands of individuals; hibernates in limestone caves of Edwards Plateau and gypsum cave of Panhandle during winter; opportunistic insectivore

Jaguarundi *Herpailurus yaguarondi* Federal Status: LE State Status: E

thick brushlands, near water favored; 60 to 75 day gestation, young born sometimes twice per year in March and August, elsewhere the beginning of the rainy season and end of the dry season

Ocelot *Leopardus pardalis* Federal Status: LE State Status: E

dense chaparral thickets; mesquite-thorn scrub and live oak mottes; avoids open areas; breeds and raises young June-November

Plains spotted skunk *Spilogale putorius interrupta*

catholic; open fields, prairies, croplands, fence rows, farmyards, forest edges, and woodlands; prefers wooded, brushy areas and tallgrass prairie

White-nosed coati *Nasua narica* State Status: T

JIM HOGG COUNTY

MAMMALS

Federal Status State Status

woodlands, riparian corridors and canyons; most individuals in Texas probably transients from Mexico; diurnal and crepuscular; very sociable; forages on ground and in trees; omnivorous; may be susceptible to hunting, trapping, and pet trade

REPTILES

Federal Status State Status

Reticulate collared lizard	*Crotaphytus reticulatus*		T

requires open brush-grasslands; thorn-scrub vegetation, usually on well-drained rolling terrain of shallow gravel, caliche, or sandy soils; often on scattered flat rocks below escarpments or isolated rock outcrops among scattered clumps of prickly pear and mesquite

Spot-tailed earless lizard *Holbrookia lacerata*

central and southern Texas and adjacent Mexico; moderately open prairie-brushland; fairly flat areas free of vegetation or other obstructions, including disturbed areas; eats small invertebrates; eggs laid underground

Texas horned lizard *Phrynosoma cornutum* T

open, arid and semi-arid regions with sparse vegetation, including grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive; breeds March-September

Texas indigo snake *Drymarchon melanurus erebennus* T

Texas south of the Guadalupe River and Balcones Escarpment; thornbush-chaparral woodlands of south Texas, in particular dense riparian corridors; can do well in suburban and irrigated croplands if not molested or indirectly poisoned; requires moist microhabitats, such as rodent burrows, for shelter

Texas scarlet snake *Cemophora coccinea lineri* T

mixed hardwood scrub on sandy soils; feeds on reptile eggs; semi-fossorial; active April-September

Texas tortoise *Gopherus berlandieri* T

open brush with a grass understory is preferred; open grass and bare ground are avoided; when inactive occupies shallow depressions at base of bush or cactus, sometimes in underground burrows or under objects; longevity greater than 50 years; active March-November; breeds April-November

PLANTS

Federal Status State Status

Amelia's abronia *Abronia ameliae*

Endemic to South Texas; Occurs on deep, well-drained sandy soils of the South Texas Sand Sheet in grassy and/or herbaceous dominated openings within coastal live oak woodlands or mesquite-coastal live oak woodlands. Perennial; Flowering Mar-June

Arrowleaf milkvine *Matelea sagittifolia*

GLOBAL RANK: G3 ; Most consistently encountered in thornscrub in South Texas; Perennial; Flowering March-July; Fruiting April-July & Dec?

JIM HOGG COUNTY

PLANTS

Federal Status State Status

Bushy whitlow-wort *Paronychia congesta*

Texas endemic; sparingly vegetated openings in thorn shrublands on extremely shallow, highly limey, soils over caliche or calcareous rock of the Goliad Formation, on moderate slopes along its contact with the Catahoula and Frio formations; flowering mostly April-June, but as late as August, probably sporadically after rains throughout the season

Cory's croton *Croton coryi*

GLOBAL RANK: G3; Grasslands and woodland openings on barrier islands and coastal sands of South Texas, inland on South Texas Sand Sheet; Annual; Flowering July-Oct; Fruiting July-Nov

Fitch's hedgehog cactus *Echinocereus reichenbachii var. fitchii*

GLOBAL RANK: G5T3; Grasslands, thorn shrublands, and mesquite-acacia woodlands on sandy, possibly somewhat saline, soils on the coastal prairie. Within these communities, the plants may be most frequently found in open areas that are somewhat sparsely covered with brush of a low stature. Frequently grows at the ecotone where these upland areas meet lower areas dominated by halophytic grasses and forbs; Perennial

Sand Brazos mint *Brazoria arenaria*

GLOBAL RANK: G3; Sandy areas in South Texas; Annual; Flowering/Fruiting March-April

South Texas gilia *Gilia ludens*

GLOBAL RANK: G3; Occurs in open areas in shrublands on shallow sandy loam over rock outcrops; Perennial; Flowering Dec-April; Fruiting March

Stinking rushpea *Pomaria austrotexana*

GLOBAL RANK: G3; In open areas on deep well drained sands; Perennial; Flowering Feb-Oct; Fruiting April-Oct

Texas peachbush *Prunus texana*

GLOBAL RANK: G3; Occurs at scattered sites in various well drained sandy situations; deep sand, plains and sand hills, grasslands, oak woods, 0-200 m elevation; Perennial; Flowering Feb-Mar; Fruiting Apr-Jun

Yellow-flowered alicoche *Echinocereus papillosus*

GLOBAL RANK: G3; Under shrubs or in open areas on various substrates; Perennial; Flowering Jan-April

KENEDY COUNTY

AMPHIBIANS

		Federal Status	State Status
Black-spotted newt	*Notophthalmus meridionalis*		T

can be found in wet or sometimes wet areas, such as arroyos, canals, ditches, or even shallow depressions; aestivates in the ground during dry periods; Gulf Coastal Plain south of the San Antonio River

Mexican treefrog	*Smilisca baudinii*		T

subtropical region of extreme southern Texas; breeds May-October coinciding with rainfall, eggs laid in temporary rain pools

Sheep frog	*Hypopachus variolosus*		T

predominantly grassland and savanna; moist sites in arid areas

South Texas siren (large form)	*Siren sp 1*		T

wet or sometimes wet areas, such as arroyos, canals, ditches, or even shallow depressions; aestivates in the ground during dry periods, but does require some moisture to remain; southern Texas south of Balcones Escarpment; breeds February-June

BIRDS

		Federal Status	State Status
American Peregrine Falcon	*Falco peregrinus anatum*	DL	T

year-round resident and local breeder in west Texas, nests in tall cliff eyries; also, migrant across state from more northern breeding areas in US and Canada, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.

Arctic Peregrine Falcon	*Falco peregrinus tundrius*	DL	

migrant throughout state from subspecies’ far northern breeding range, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.

Audubon's Oriole	*Icterus graduacauda audubonii*		

scrub, mesquite; nests in dense trees, or thickets, usually along water courses

Brown Pelican	*Pelecanus occidentalis*	DL	

largely coastal and near shore areas, where it roosts and nests on islands and spoil banks

Cactus Ferruginous Pygmy-Owl	*Glaucidium brasilianum cactorum*		T

riparian trees, brush, palm, and mesquite thickets; during day also roosts in small caves and recesses on slopes of low hills; breeding April to June

Eskimo Curlew	*Numenius borealis*	LE	E

historic; nonbreeding: grasslands, pastures, plowed fields, and less frequently, marshes and mudflats

KENEDY COUNTY

BIRDS

		Federal Status	State Status
Mountain Plover	*Charadrius montanus*		

breeding: nests on high plains or shortgrass prairie, on ground in shallow depression; nonbreeding: shortgrass plains and bare, dirt (plowed) fields; primarily insectivorous

Northern Aplomado Falcon	*Falco femoralis septentrionalis*	LE	E

open country, especially savanna and open woodland, and sometimes in very barren areas; grassy plains and valleys with scattered mesquite, yucca, and cactus; nests in old stick nests of other bird species

Northern Beardless-Tyrannulet	*Camptostoma imberbe*		T

mesquite woodlands; near Rio Grande frequents cottonwood, willow, elm, and great leadtree; breeding April to July

Peregrine Falcon	*Falco peregrinus*	DL	T

both subspecies migrate across the state from more northern breeding areas in US and Canada to winter along coast and farther south; subspecies (F. p. anatum) is also a resident breeder in west Texas; the two subspecies' listing statuses differ, F.p. tundrius is no longer listed in Texas; but because the subspecies are not easily distinguishable at a distance, reference is generally made only to the species level; see subspecies for habitat.

Piping Plover	*Charadrius melodus*	LT	T

wintering migrant along the Texas Gulf Coast; beaches and bayside mud or salt flats

Red Knot	*Calidris canutus rufa*	T	

Red knots migrate long distances in flocks northward through the contiguous United States mainly April-June, southward July-October. A small plump-bodied, short-necked shorebird that in breeding plumage, typically held from May through August, is a distinctive and unique pottery orange color. Its bill is dark, straight and, relative to other shorebirds, short-to-medium in length. After molting in late summer, this species is in a drab gray-and-white non-breeding plumage, typically held from September through April. In the non-breeding plumage, the knot might be confused with the omnipresent Sanderling. During this plumage, look for the knot's prominent pale eyebrow and whitish flanks with dark barring. The Red Knot prefers the shoreline of coast and bays and also uses mudflats during rare inland encounters. Primary prey items include coquina clam (Donax spp.) on beaches and dwarf surf clam (Mulinia lateralis) in bays, at least in the Laguna Madre. Wintering Range includes- Aransas, Brazoria, Calhoun, Cameron, Chambers, Galveston, Jefferson, Kennedy, Kleberg, Matagorda, Nueces, San Patricio, and Willacy. Habitat: Primarily seacoasts on tidal flats and beaches, herbaceous wetland, and Tidal flat/shore.

Reddish Egret	*Egretta rufescens*		T

resident of the Texas Gulf Coast; brackish marshes and shallow salt ponds and tidal flats; nests on ground or in trees or bushes, on dry coastal islands in brushy thickets of yucca and prickly pear

Rose-throated Becard	*Pachyramphus aglaiae*		T

riparian trees, woodlands, open forest, scrub, and mangroves; breeding April to July

Sennett's Hooded Oriole	*Icterus cucullatus sennetti*		

often builds nests in and of Spanish moss (Tillandsia unioides); feeds on invertebrates, fruit, and nectar; breeding March to August

KENEDY COUNTY

BIRDS		Federal Status	State Status
Snowy Plover	*Charadrius alexandrinus*		

formerly an uncommon breeder in the Panhandle; potential migrant; winter along coast

Sooty Tern	*Sterna fuscata*		T

predominately 'on the wing'; does not dive, but snatches small fish and squid with bill as it flies or hovers over water; breeding April-July

Sprague's Pipit	*Anthus spragueii*		

only in Texas during migration and winter, mid September to early April; short to medium distance, diurnal migrant; strongly tied to native upland prairie, can be locally common in coastal grasslands, uncommon to rare further west; sensitive to patch size and avoids edges.

Texas Botteri's Sparrow	*Aimophila botterii texana*		T

grassland and short-grass plains with scattered bushes or shrubs, sagebrush, mesquite, or yucca; nests on ground of low clump of grasses

Tropical Parula	*Parula pitiayumi*		T

dense or open woods, undergrowth, brush, and trees along edges of rivers and resacas; breeding April to July

Western Burrowing Owl	*Athene cunicularia hypugaea*		

open grasslands, especially prairie, plains, and savanna, sometimes in open areas such as vacant lots near human habitation or airports; nests and roosts in abandoned burrows

Western Snowy Plover	*Charadrius alexandrinus nivosus*		

uncommon breeder in the Panhandle; potential migrant; winter along coast

White-faced Ibis	*Plegadis chihi*		T

prefers freshwater marshes, sloughs, and irrigated rice fields, but will attend brackish and saltwater habitats; nests in marshes, in low trees, on the ground in bulrushes or reeds, or on floating mats

White-tailed Hawk	*Buteo albicaudatus*		T

near coast on prairies, cordgrass flats, and scrub-live oak; further inland on prairies, mesquite and oak savannas, and mixed savanna-chaparral; breeding March-May

Whooping Crane	*Grus americana*	LE	E

potential migrant via plains throughout most of state to coast; winters in coastal marshes of Aransas, Calhoun, and Refugio counties

Wood Stork	*Mycteria americana*		T

forages in prairie ponds, flooded pastures or fields, ditches, and other shallow standing water, including salt-water; usually roosts communally in tall snags, sometimes in association with other wading birds (i.e. active heronries); breeds in Mexico and birds move into Gulf States in search of mud flats and other wetlands, even those associated with forested areas; formerly nested in Texas, but no breeding records since 1960

KENEDY COUNTY

BIRDS		Federal Status	State Status
Zone-tailed Hawk	*Buteo albonotatus*		T

arid open country, including open deciduous or pine-oak woodland, mesa or mountain county, often near watercourses, and wooded canyons and tree-lined rivers along middle-slopes of desert mountains; nests in various habitats and sites, ranging from small trees in lower desert, giant cottonwoods in riparian areas, to mature conifers in high mountain regions

FISHES		Federal Status	State Status
American eel	*Anguilla rostrata*		

coastal waterways below reservoirs to gulf; spawns January to February in ocean, larva move to coastal waters, metamorphose, then females move into freshwater; most aquatic habitats with access to ocean, muddy bottoms, still waters, large streams, lakes; can travel overland in wet areas; males in brackish estuaries; diet varies widely, geographically, and seasonally

Opossum pipefish	*Microphis brachyurus*		T

brooding adults found in fresh or low salinity waters and young move or are carried into more saline waters after birth; southern coastal areas

Smalltooth sawfish	*Pristis pectinata*	LE	E

different life history stages have different patterns of habitat use; young found very close to shore in muddy and sandy bottoms, seldom descending to depths greater than 32 ft (10 m); in sheltered bays, on shallow banks, and in estuaries or river mouths; adult sawfish are encountered in various habitat types (mangrove, reef, seagrass, and coral), in varying salinity regimes and temperatures, and at various water depths, feed on a variety of fish species and crustaceans

INSECTS		Federal Status	State Status
Los Olmos tiger beetle	*Cicindela nevadica olmosa*		

most tiger beetles are active, usually brightly colored, and found in open, sunny areas; adult tiger beetles are predaceous and feed on a variety of small insects; larvae of tiger beetles are also predaceous and live in vertical burrows in soil of dry paths, fields, or sandy beaches

Superb grasshopper	*Eximacris superbum*		

collected in south Texas, but repeated efforts to collect not successful; may over-winter in adult stage

Texas asaphomyian tabanid fly	*Asaphomyia texensis*		

globally historic; adults of tabanid spp. found near slow-moving water; eggs laid in masses on leaves or other objects near or over water; larvae are aquatic and predaceous; females of tabanid spp. bite, while males chiefly feed on pollen and nectar; using sight, carbon dioxide, and odor for selection, tabanid spp. lie in wait in shady areas under bushes and trees for a host to happen by

KENEDY COUNTY

MAMMALS

		Federal Status	State Status
Coues' rice rat	*Oryzomys couesi*		T

cattail-bulrush marsh with shallower zone of aquatic grasses near the shoreline; shade trees around the shoreline are important features; prefers salt and freshwater, as well as grassy areas near water; breeds April-August

Jaguar	*Panthera onca*	LE	E

extirpated; dense chaparral; no reliable TX sightings since 1952

Jaguarundi	*Herpailurus yaguarondi*	LE	E

thick brushlands, near water favored; 60 to 75 day gestation, young born sometimes twice per year in March and August, elsewhere the beginning of the rainy season and end of the dry season

Ocelot	*Leopardus pardalis*	LE	E

dense chaparral thickets; mesquite-thorn scrub and live oak mottes; avoids open areas; breeds and raises young June-November

Plains spotted skunk	*Spilogale putorius interrupta*		

catholic; open fields, prairies, croplands, fence rows, farmyards, forest edges, and woodlands; prefers wooded, brushy areas and tallgrass prairie

Red wolf	*Canis rufus*	LE	E

extirpated; formerly known throughout eastern half of Texas in brushy and forested areas, as well as coastal prairies

Southern yellow bat	*Lasiurus ega*		T

associated with trees, such as palm trees (Sabal mexicana) in Brownsville, which provide them with daytime roosts; insectivorous; breeding in late winter

West Indian manatee	*Trichechus manatus*	LE	E

Gulf and bay system; opportunistic, aquatic herbivore

White-nosed coati	*Nasua narica*		T

woodlands, riparian corridors and canyons; most individuals in Texas probably transients from Mexico; diurnal and crepuscular; very sociable; forages on ground and in trees; omnivorous; may be susceptible to hunting, trapping, and pet trade

REPTILES

		Federal Status	State Status
Atlantic hawksbill sea turtle	*Eretmochelys imbricata*	LE	E

Gulf and bay system, warm shallow waters especially in rocky marine environments, such as coral reefs and jetties, juveniles found in floating mats of sea plants; feed on sponges, jellyfish, sea urchins, molluscs, and crustaceans, nests April through November

Black-striped snake	*Coniophanes imperialis*		T

extreme south Texas; semi-arid coastal plain, warm, moist micro-habitats and sandy soils; proficient burrower; eggs laid April-June

KENEDY COUNTY

REPTILES

		Federal Status	State Status
Green sea turtle	*Chelonia mydas*	LT	T

Gulf and bay system; shallow water seagrass beds, open water between feeding and nesting areas, barrier island beaches; adults are herbivorous feeding on sea grass and seaweed; juveniles are omnivorous feeding initially on marine invertebrates, then increasingly on sea grasses and seaweeds; nesting behavior extends from March to October, with peak activity in May and June

Keeled earless lizard	*Holbrookia propinqua*		

coastal dunes, barrier islands, and other sandy areas; eats insects and likely other small invertebrates; eggs laid underground March-September (most May-August)

Kemp's Ridley sea turtle	*Lepidochelys kempii*	LE	E

Gulf and bay system, adults stay within the shallow waters of the Gulf of Mexico; feed primarily on crabs, but also snails, clams, other crustaceans and plants, juveniles feed on sargassum and its associated fauna; nests April through August

Leatherback sea turtle	*Dermochelys coriacea*	LE	E

Gulf and bay systems, and widest ranging open water reptile; omnivorous, shows a preference for jellyfish; in the US portion of their western Atlantic nesting territories, nesting season ranges from March to August

Loggerhead sea turtle	*Caretta caretta*	LT	T

Gulf and bay system primarily for juveniles, adults are most pelagic of the sea turtles; omnivorous, shows a preference for mollusks, crustaceans, and coral; nests from April through November

Northern cat-eyed snake	*Leptodeira septentrionalis septentrionalis*		T

Gulf Coastal Plain south of the Nueces River; thorn brush woodland; dense thickets bordering ponds and streams; semi-arboreal; nocturnal

Spot-tailed earless lizard	*Holbrookia lacerata*		

central and southern Texas and adjacent Mexico; moderately open prairie-brushland; fairly flat areas free of vegetation or other obstructions, including disturbed areas; eats small invertebrates; eggs laid underground

Texas horned lizard	*Phrynosoma cornutum*		T

open, arid and semi-arid regions with sparse vegetation, including grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive; breeds March-September

Texas indigo snake	*Drymarchon melanurus erebennus*		T

Texas south of the Guadalupe River and Balcones Escarpment; thornbush-chaparral woodlands of south Texas, in particular dense riparian corridors; can do well in suburban and irrigated croplands if not molested or indirectly poisoned; requires moist microhabitats, such as rodent burrows, for shelter

Texas scarlet snake	*Cemophora coccinea lineri*		T

mixed hardwood scrub on sandy soils; feeds on reptile eggs; semi-fossorial; active April-September

KENEDY COUNTY

REPTILES

		Federal Status	State Status
Texas tortoise	*Gopherus berlandieri*		T

open brush with a grass understory is preferred; open grass and bare ground are avoided; when inactive occupies shallow depressions at base of bush or cactus, sometimes in underground burrows or under objects; longevity greater than 50 years; active March-November; breeds April-November

PLANTS

Federal Status State Status

Amelia's abronia *Abronia ameliae*

Endemic to South Texas; Occurs on deep, well-drained sandy soils of the South Texas Sand Sheet in grassy and/or herbaceous dominated openings within coastal live oak woodlands or mesquite-coastal live oak woodlands. Perennial; Flowering Mar-June

Bailey's ballmoss *Tillandsia baileyi*

epiphytic on various trees and tall shrubs, perhaps most common in mottes of Live oak on vegtated dunes and flats in coastal portions of the South Texas Sand Sheet, but also on evergreen sub-tropical woodlands along resacas in the Lower Rio Grande Valley; flowering (February-)April-May, but conspicuous throughout the year

Bristle nailwort *Paronychia setacea*

Flowering vascular plant endemic to eastern southcentral Texas, occurring in sandy soils

Cory's croton *Croton coryi*

GLOBAL RANK: G3; Grasslands and woodland openings on barrier islands and coastal sands of South Texas, inland on South Texas Sand Sheet; Annual; Flowering July-Oct; Fruiting July-Nov

Elmendorf's onion *Allium elmendorfii*

Texas endemic; grassland openings in oak woodlands on deep, loose, well-drained sands; in Coastal Bend, on Pleistocene barrier island ridges and Holocene Sand Sheet that support live oak woodlands; to the north it occurs in post oak-black hickory-live oak woodlands over Queen City and similar Eocene formations; one anomalous specimen found on Llano Uplift in wet pockets of granitic loam; Perennial; Flowering March-April, May

Jones' nailwort *Paronychia jonesii*

GLOBAL RANK: G3; Occurs in early successional open areas on deep well-drained sand; Biennial Annual; Flowering March-Nov; Fruiting April-Nov

Roughseed sea-purslane *Sesuvium trianthemoides*

Texas endemic; dunes and perhaps in saline clay of tidal flats or ephemeral ponds within a dune landscape; likely flowering June-August

Sand Brazos mint *Brazoria arenaria*

GLOBAL RANK: G3; Sandy areas in South Texas; Annual; Flowering/Fruiting March-April

Shortcrown milkvine *Matelea brevicoronata*

GLOBAL RANK: G3; Primarily in grasslands on tight sandy or silty substrates; Perennial; Flowering March-Sept; Fruiting May-Sept

KENEDY COUNTY

PLANTS

Federal Status State Status

South Texas spikesedge *Eleocharis austrotexana*

GLOBAL RANK: G3; Occurring in miscellaneous wetlands at scattered locations on the coastal plain; Perennial; Flowering/Fruiting Sept

Stinking rushpea *Pomaria austrotexana*

GLOBAL RANK: G3; In open areas on deep well drained sands; Perennial; Flowering Feb-Oct; Fruiting April-Oct

Texas peachbush *Prunus texana*

GLOBAL RANK: G3; Occurs at scattered sites in various well drained sandy situations; deep sand, plains and sand hills, grasslands, oak woods, 0-200 m elevation; Perennial; Flowering Feb-Mar; Fruiting Apr-Jun

Texas stonecrop *Lenophyllum texanum*

GLOBAL RANK: G3; Found in shrublands on clay dunes (lomas) at the mouth of the Rio Grande and on xeric calcareous rock outcrops at scattered inland sites; Perennial; Flowering/Fruiting Nov-Feb

Velvet spurge *Euphorbia innocua*

GLOBAL RANK: G3; Open or brushy areas on coastal sands and the South Texas Sand Sheet; Perennial; Flowering Sept-April; Fruiting Nov-July

Wright's trichocoronis *Trichocoronis wrightii var. wrightii*

GLOBAL RANK: G4T3; Most records from Texas are historical, perhaps indicating a decline as a result of alteration of wetland habitats; Annual; Flowering Feb-Oct; Fruiting Feb-Sept

STARR COUNTY

AMPHIBIANS

		Federal Status	State Status
Black-spotted newt	*Notophthalmus meridionalis*		T

can be found in wet or sometimes wet areas, such as arroyos, canals, ditches, or even shallow depressions; aestivates in the ground during dry periods; Gulf Coastal Plain south of the San Antonio River

Mexican burrowing toad	*Rhinophrynus dorsalis*		T

roadside ditches, temporary ponds, arroyos, or wherever loose friable soils are present in which to burrow; generally underground emerging only to breed or during rainy periods

Mexican treefrog	*Smilisca baudinii*		T

subtropical region of extreme southern Texas; breeds May-October coinciding with rainfall, eggs laid in temporary rain pools

Sheep frog	*Hypopachus variolosus*		T

predominantly grassland and savanna; moist sites in arid areas

South Texas siren (large form)	*Siren sp 1*		T

wet or sometimes wet areas, such as arroyos, canals, ditches, or even shallow depressions; aestivates in the ground during dry periods, but does require some moisture to remain; southern Texas south of Balcones Escarpment; breeds February-June

White-lipped frog	*Leptodactylus fragilis*		T

grasslands, cultivated fields, roadside ditches, and a wide variety of other habitats; often hides under rocks or in burrows under clumps of grass; species requirements incompatible with widespread habitat alteration and pesticide use in south Texas

BIRDS

		Federal Status	State Status
American Peregrine Falcon	*Falco peregrinus anatum*	DL	T

year-round resident and local breeder in west Texas, nests in tall cliff eyries; also, migrant across state from more northern breeding areas in US and Canada, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.

Arctic Peregrine Falcon	*Falco peregrinus tundrius*	DL	

migrant throughout state from subspecies' far northern breeding range, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.

Audubon's Oriole	*Icterus graduacauda audubonii*		

scrub, mesquite; nests in dense trees, or thickets, usually along water courses

STARR COUNTY

BIRDS

		Federal Status	State Status
Brown Jay	*Cyanocorax morio*		

woodlands and mesquite along the Rio Grande; dense brushy woods, open woods, forest edge, second-growth woodland, clearings, plantation; nests in tree or shrub often far out on limb, usually 7-21 meters above ground

Brownsville Common Yellowthroat	*Geothlypis trichas insperata*		

tall grasses and bushes near ponds, marshes, and swamps; breeding April to July

Cactus Ferruginous Pygmy-Owl	*Glaucidium brasilianum cactorum*		T

riparian trees, brush, palm, and mesquite thickets; during day also roosts in small caves and recesses on slopes of low hills; breeding April to June

Common Black-Hawk	*Buteogallus anthracinus*		T

cottonwood-lined rivers and streams; willow tree groves on the lower Rio Grande floodplain; formerly bred in south Texas

Gray Hawk	*Asturina nitida*		T

locally and irregularly along U.S.-Mexico border; mature riparian woodlands and nearby semiarid mesquite and scrub grasslands; breeding range formerly extended north to southernmost Rio Grande floodplain of Texas

Hook-billed Kite	*Chondrohierax uncinatus*		

dense tropical and subtropical forests, but does occur in open woodlands; uncommon to rare in most of range; accidental in south Texas

Interior Least Tern	*Sterna antillarum athalassos*	LE	E

subspecies is listed only when inland (more than 50 miles from a coastline); nests along sand and gravel bars within braided streams, rivers; also know to nest on man-made structures (inland beaches, wastewater treatment plants, gravel mines, etc); eats small fish and crustaceans, when breeding forages within a few hundred feet of colony

Mexican Hooded Oriole	*Icterus cucullatus cucullatus*		

scrub, mesquite; nests in dense trees, or thickets, usually along water courses

Northern Beardless-Tyrannulet	*Camptostoma imberbe*		T

mesquite woodlands; near Rio Grande frequents cottonwood, willow, elm, and great leadtree; breeding April to July

Peregrine Falcon	*Falco peregrinus*	DL	T

both subspecies migrate across the state from more northern breeding areas in US and Canada to winter along coast and farther south; subspecies (F. p. anatum) is also a resident breeder in west Texas; the two subspecies' listing statuses differ, F.p. tundrius is no longer listed in Texas; but because the subspecies are not easily distinguishable at a distance, reference is generally made only to the species level; see subspecies for habitat.

STARR COUNTY

BIRDS

		Federal Status	State Status
Rose-throated Becard	*Pachyramphus aglaiae*		T

riparian trees, woodlands, open forest, scrub, and mangroves; breeding April to July

Sennett's Hooded Oriole	*Icterus cucullatus sennetti*		

often builds nests in and of Spanish moss (Tillandsia unioides); feeds on invertebrates, fruit, and nectar; breeding March to August

Sprague's Pipit	*Anthus spragueii*		

only in Texas during migration and winter, mid September to early April; short to medium distance, diurnal migrant; strongly tied to native upland prairie, can be locally common in coastal grasslands, uncommon to rare further west; sensitive to patch size and avoids edges.

Tropical Parula	*Parula pitiayumi*		T

dense or open woods, undergrowth, brush, and trees along edges of rivers and resacas; breeding April to July

Western Burrowing Owl	*Athene cunicularia hypugaea*		

open grasslands, especially prairie, plains, and savanna, sometimes in open areas such as vacant lots near human habitation or airports; nests and roosts in abandoned burrows

White-tailed Hawk	*Buteo albicaudatus*		T

near coast on prairies, cordgrass flats, and scrub-live oak; further inland on prairies, mesquite and oak savannas, and mixed savanna-chaparral; breeding March-May

Wood Stork	*Mycteria americana*		T

forages in prairie ponds, flooded pastures or fields, ditches, and other shallow standing water, including salt-water; usually roosts communally in tall snags, sometimes in association with other wading birds (i.e. active heronries); breeds in Mexico and birds move into Gulf States in search of mud flats and other wetlands, even those associated with forested areas; formerly nested in Texas, but no breeding records since 1960

Zone-tailed Hawk	*Buteo albonotatus*		T

arid open country, including open deciduous or pine-oak woodland, mesa or mountain county, often near watercourses, and wooded canyons and tree-lined rivers along middle-slopes of desert mountains; nests in various habitats and sites, ranging from small trees in lower desert, giant cottonwoods in riparian areas, to mature conifers in high mountain regions

FISHES

		Federal Status	State Status
Rio Grande shiner	*Notropis jemezanus*		

Rio Grande and upper Pecos River basins; large, open, weedless rivers or large creeks with bottom of rubble, gravel and sand, often overlain with silt

STARR COUNTY

FISHES		Federal Status	State Status
Rio Grande silvery minnow	*Hybognathus amarus*	LE	E

extirpated; historically Rio Grande and Pecos River systems and canals; reintroduced in Big Bend area; pools and backwaters of medium to large streams with low or moderate gradient in mud, sand, or gravel bottom; ingests mud and bottom ooze for algae and other organic matter; probably spawns on silt substrates of quiet coves

INSECTS		Federal Status	State Status
A tiger beetle	*Tetracha affinis angustata*		

most tiger beetles diurnal, open sandy areas, beaches, open paths or lanes, or on mudflats; larvae in hard-packed ground in vertical burrows

Cazier's tiger beetle	*Cicindela cazieri*		

most tiger beetles are active, usually brightly colored, and found in open, sunny areas; adult tiger beetles are predaceous and feed on a variety of small insects; larvae of tiger beetles are also predaceous and live in vertical burrows in soil of dry paths, fields, or sandy beaches

Neojuvenile tiger beetle	*Cicindela obsoleta neojuvenilis*		

bare or sparsely vegetated, dry, hard-packed soil; typically in previously disturbed areas; peak adult activity in Jul

MAMMALS		Federal Status	State Status
Cave myotis bat	*Myotis velifer*		

colonial and cave-dwelling; also roosts in rock crevices, old buildings, carports, under bridges, and even in abandoned Cliff Swallow (Hirundo pyrrhonota) nests; roosts in clusters of up to thousands of individuals; hibernates in limestone caves of Edwards Plateau and gypsum cave of Panhandle during winter; opportunistic insectivore

Coues' rice rat	*Oryzomys couesi*		T

cattail-bulrush marsh with shallower zone of aquatic grasses near the shoreline; shade trees around the shoreline are important features; prefers salt and freshwater, as well as grassy areas near water; breeds April-August

Jaguarundi	*Herpailurus yaguarondi*	LE	E

thick brushlands, near water favored; 60 to 75 day gestation, young born sometimes twice per year in March and August, elsewhere the beginning of the rainy season and end of the dry season

Mexican long-tongued bat	*Choeronycteris mexicana*		

deep canyons where uses caves and mine tunnels as day roosts; also found in buildings and often associated with big-eared bats (Plecotus spp.); single TX record from Santa Ana NWR

Ocelot	*Leopardus pardalis*	LE	E

dense chaparral thickets; mesquite-thorn scrub and live oak mottes; avoids open areas; breeds and raises young June-November

STARR COUNTY

MAMMALS

		Federal Status	State Status
Plains spotted skunk	*Spilogale putorius interrupta*		

catholic; open fields, prairies, croplands, fence rows, farmyards, forest edges, and woodlands; prefers wooded, brushy areas and tallgrass prairie

White-nosed coati	*Nasua narica*		T

woodlands, riparian corridors and canyons; most individuals in Texas probably transients from Mexico; diurnal and crepuscular; very sociable; forages on ground and in trees; omnivorous; may be susceptible to hunting, trapping, and pet trade

MOLLUSKS

		Federal Status	State Status
Mexican fawnsfoot mussel	*Truncilla cognata*		T

largely unknown; possibly intolerant of impoundment; possibly needs flowing streams and rivers with sand or gravel bottoms based on related species needs; Rio Grande basin

Salina mucket	*Potamilus metnecktayi*		T

lotic waters; submerged soft sediment (clay and silt) along river bank; other habitat requirements are poorly understood; Rio Grande Basin

Texas hornshell	*Popenaias popeii*	C	T

both ends of narrow shallow runs over bedrock, in areas where small-grained materials collect in crevices, along river banks, and at the base of boulders; not known from impoundments; Rio Grande Basin and several rivers in Mexico

REPTILES

		Federal Status	State Status
Northern cat-eyed snake	*Leptodeira septentrionalis septentrionalis*		T

Gulf Coastal Plain south of the Nueces River; thorn brush woodland; dense thickets bordering ponds and streams; semi-arboreal; nocturnal

Reticulate collared lizard	*Crotaphytus reticulatus*		T

requires open brush-grasslands; thorn-scrub vegetation, usually on well-drained rolling terrain of shallow gravel, caliche, or sandy soils; often on scattered flat rocks below escarpments or isolated rock outcrops among scattered clumps of prickly pear and mesquite

Spot-tailed earless lizard	*Holbrookia lacerata*		

central and southern Texas and adjacent Mexico; moderately open prairie-brushland; fairly flat areas free of vegetation or other obstructions, including disturbed areas; eats small invertebrates; eggs laid underground

Texas horned lizard	*Phrynosoma cornutum*		T

open, arid and semi-arid regions with sparse vegetation, including grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive; breeds March-September

STARR COUNTY

REPTILES

		Federal Status	State Status
Texas indigo snake	*Drymarchon melanurus erebennus*		T

Texas south of the Guadalupe River and Balcones Escarpment; thornbush-chaparral woodlands of south Texas, in particular dense riparian corridors; can do well in suburban and irrigated croplands if not molested or indirectly poisoned; requires moist microhabitats, such as rodent burrows, for shelter

Texas tortoise	*Gopherus berlandieri*		T

open brush with a grass understory is preferred; open grass and bare ground are avoided; when inactive occupies shallow depressions at base of bush or cactus, sometimes in underground burrows or under objects; longevity greater than 50 years; active March-November; breeds April-November

PLANTS

		Federal Status	State Status
Amelia's abronia	*Abronia ameliae*		

Endemic to South Texas; Occurs on deep, well-drained sandy soils of the South Texas Sand Sheet in grassy and/or herbaceous dominated openings within coastal live oak woodlands or mesquite-coastal live oak woodlands. Perennial; Flowering Mar-June

Arrowleaf milkvine	*Matelea sagittifolia*		

GLOBAL RANK: G3 ; Most consistently encountered in thornscrub in South Texas; Perennial; Flowering March-July; Fruiting April-July & Dec?

Ashy dogweed	*Thymophylla tephroleuca*	LE	E

Texas endemic; grasslands with scattered shrubs; most sites on sands or sandy loams on level or very gently rolling topography over Eocene strata of the Laredo Formation; flowering March-May depending to some extent on rainfall

Chihuahua balloon-vine	*Cardiospermum dissectum*		

Thorn shrublands or low woodlands on well to excessively well drained, calcareous, sandy to gravelly soils in drier uplands of the Lower Rio Grande Valley, in areas underlain by the Goliad formation, Catahoula and Frio formations undivided, Jackson Group, and other Eocene formations; during drought conditions the normally inconspicuous slender twining vine turns a more conspicuous deep reddish-purple; flowering (April-) July-September, probably throughout the growing season in response to rainfall.

Cory's croton	*Croton coryi*		

GLOBAL RANK: G3; Grasslands and woodland openings on barrier islands and coastal sands of South Texas, inland on South Texas Sand Sheet; Annual; Flowering July-Oct; Fruiting July-Nov

Fitch's hedgehog cactus	*Echinocereus reichenbachii var. fitchii*		

GLOBAL RANK: G5T3; Grasslands, thorn shrublands, and mesquite-acacia woodlands on sandy, possibly somewhat saline, soils on the coastal prairie. Within these communities, the plants may be most frequently found in open areas that are somewhat sparsely covered with brush of a low stature. Frequently grows at the ecotone where these upland areas meet lower areas dominated by halophytic grasses and forbs; Perennial

STARR COUNTY

PLANTS

Federal Status | State Status

Gregg's wild-buckwheat *Eriogonum greggii*

sparingly vegetated openings in thorn shrublands in shallow soils on xeric ridges along the Rio Grande; also on excessively drained, sandy soil over caliche and calcareous sandstone of the Goliad Formation and over sandstone or fossiliferous layers of the Jackson Group; flowering February-July, probably opportunistically during the growing season

Johnston's frankenia *Frankenia johnstonii* LE-PDL E

dwarf shrublands on strongly saline, highly alkaline, calcareous or gypseous, clayey to sandy soils of valley flats or rocky slopes; mapped soils at many sites are of the Catarina and/or Maverick Series, other mapped soils include Copita, Brennan, Zapata, and Montell series; most sites are underlain by Eocene sandstones and clays of the Jackson Group or the Yegua and Laredo formations; a few are underlain by El Pico clay or the Catahoula and Frio formations shrublands; flowering throughout the growing season depending upon rainfall

Jones' nailwort *Paronychia jonesii*

GLOBAL RANK: G3; Occurs in early successional open areas on deep well-drained sand; Biennial Annual; Flowering March-Nov; Fruiting April-Nov

Kleberg saltbush *Atriplex klebergorum*

Texas endemic; usually occurs in sparsely vegetated saline areas, including flats and draws; in light sandy or clayey loam soils with other halophytes; occasionally observed on scraped oil pad sites; observed flowering in late August-early September, but may vary with rainfall, fruits are usually present in fall; because of its annual nature, populations fluctuate widely from year to year

Prostrate milkweed *Asclepias prostrata*

grasslands or openings in shrublands on loamy fine sands and fine sandy loams of the Copita, Hebbronville, and possibly other soil series occurring over the Laredo, Yegua, and other Eocene formations; also in Loreto caliche sand plain in Tamaulipas; flowering April-October, but may be sporadic and dependent on rainfall

Runyon's cory cactus *Coryphantha macromeris var runyonii*

gravelly to sandy or clayey, calcareous, sometimes gypsiferous or saline soils, often over the Catahoula and Frio formations, on gentle hills and slopes to the flats between, at elevations ranging from 10 to 150 m (30 to 500 ft); ?late spring or early summer, November, fruit has been collected in August

Sand sheet leaf-flower *Phyllanthus abnormis var. riograndensis*

GLOBAL RANK: G5T3; Semi-desert scrub of deep South Texas; Annual; Flowering Feb-July; Fruiting Oct-March

Shinners' rocket *Thelypodiopsis shinnersii*

mostly along margins of Tamaulipan thornscrub on clay soils of the Rio Grande Delta, including lomas near the mouth of the river; Tamaulipas, Mexico specimens are from mountains, with no further detail; flowering mostly March-April, with one collection in December

Shortcrown milkvine *Matelea brevicoronata*

GLOBAL RANK: G3; Primarily in grasslands on tight sandy or silty substrates; Perennial; Flowering March-Sept; Fruiting May-Sept

STARR COUNTY

PLANTS		Federal Status	State Status
Siler's huaco	*Manfreda sileri*		

GLOBAL RANK: G3; Rare in a variety of grasslands and shrublands on dry sites; Perennial; Flowering April-July; Fruiting June-July

St. Joseph's staff	*Manfreda longiflora*		

thorn shrublands on clays and loams with various concentrations of salt, caliche, sand, and gravel; rossettes are often obscured by low shrubs; flowering September-October

Star cactus	*Astrophytum asterias*	LE	E

gravelly clays or loams, possibly of the Catarina Series (deep, droughty, saline clays), over the Catahoula and Frio formations, on gentle slopes and flats in sparsely vegetated openings between shrub thickets within mesquite grasslands or mesquite-blackbrush thorn shrublands; plants sink into or below ground during dry periods; flowering from mid March-May, may also flower in warmer months after sufficient rainfall, flowers most reliably in early April; fruiting mid April-June

Stinking rushpea	*Pomaria austrotexana*		

GLOBAL RANK: G3; In open areas on deep well drained sands; Perennial; Flowering Feb-Oct; Fruiting April-Oct

Texas peachbush	*Prunus texana*		

GLOBAL RANK: G3; Occurs at scattered sites in various well drained sandy situations; deep sand, plains and sand hills, grasslands, oak woods, 0-200 m elevation; Perennial; Flowering Feb-Mar; Fruiting Apr-Jun

Texas shrimp-plant	*Yeatesia platystegia*		

GLOBAL RANK: G3G4; Occurs very sparingly in a variety of shrublands and canyon woodlands at widely scattered locations; Perennial; Flowering/Fruiting April-Dec

Texas stonecrop	*Lenophyllum texanum*		

GLOBAL RANK: G3; Found in shrublands on clay dunes (lomas) at the mouth of the Rio Grande and on xeric calcareous rock outcrops at scattered inland sites; Perennial; Flowering/Fruiting Nov-Feb

Vasey's adelia	*Adelia vaseyi*		

Mostly subtropical evergreen/deciduous woodlands on loamy soils of Rio Grande Delta, but occassionally in shrublands on more xeric sandy to gravelly upland sites; Perennial; Flowering January-June

Walker's manioc	*Manihot walkerae*	LE	E

periphery of native brush in sandy loam; also on caliche cuestas?; flowering April-September (following rains?)

Yellow-flowered alicoche	*Echinocereus papillosus*		

GLOBAL RANK: G3; Under shrubs or in open areas on various substrates; Perennial; Flowering Jan-April

Zapata bladderpod	*Physaria thamnophila*	LE	E

open, thorn shrublands on shallow, well-drained sandy loams and sandstone outcrops of Eocene origin, including the Jackson Group and Yegua and Laredo formations; the known sites' soils are mapped as Zapata, Maverick, Catarina, or Copita Series; flowering usually February-April, but also summer or fall depending on rainfall

STARR COUNTY

WILLACY COUNTY

AMPHIBIANS

		Federal Status	State Status
Black-spotted newt	*Notophthalmus meridionalis*		T

can be found in wet or sometimes wet areas, such as arroyos, canals, ditches, or even shallow depressions; aestivates in the ground during dry periods; Gulf Coastal Plain south of the San Antonio River

Mexican treefrog	*Smilisca baudinii*		T

subtropical region of extreme southern Texas; breeds May-October coinciding with rainfall, eggs laid in temporary rain pools

Sheep frog	*Hypopachus variolosus*		T

predominantly grassland and savanna; moist sites in arid areas

South Texas siren (large form)	*Siren sp 1*		T

wet or sometimes wet areas, such as arroyos, canals, ditches, or even shallow depressions; aestivates in the ground during dry periods, but does require some moisture to remain; southern Texas south of Balcones Escarpment; breeds February-June

BIRDS

		Federal Status	State Status
American Peregrine Falcon	*Falco peregrinus anatum*	DL	T

year-round resident and local breeder in west Texas, nests in tall cliff eyries; also, migrant across state from more northern breeding areas in US and Canada, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.

Arctic Peregrine Falcon	*Falco peregrinus tundrius*	DL	

migrant throughout state from subspecies' far northern breeding range, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.

Audubon's Oriole	*Icterus graduacauda audubonii*		

scrub, mesquite; nests in dense trees, or thickets, usually along water courses

Brown Pelican	*Pelecanus occidentalis*	DL	

largely coastal and near shore areas, where it roosts and nests on islands and spoil banks

Cactus Ferruginous Pygmy-Owl	*Glaucidium brasilianum cactorum*		T

riparian trees, brush, palm, and mesquite thickets; during day also roosts in small caves and recesses on slopes of low hills; breeding April to June

Common Black-Hawk	*Buteogallus anthracinus*		T

cottonwood-lined rivers and streams; willow tree groves on the lower Rio Grande floodplain; formerly bred in south Texas

WILLACY COUNTY

BIRDS

		Federal Status	State Status
Eskimo Curlew	*Numenius borealis*	LE	E

historic; nonbreeding: grasslands, pastures, plowed fields, and less frequently, marshes and mudflats

Mountain Plover	*Charadrius montanus*		

breeding: nests on high plains or shortgrass prairie, on ground in shallow depression; nonbreeding: shortgrass plains and bare, dirt (plowed) fields; primarily insectivorous

Northern Aplomado Falcon	*Falco femoralis septentrionalis*	LE	E

open country, especially savanna and open woodland, and sometimes in very barren areas; grassy plains and valleys with scattered mesquite, yucca, and cactus; nests in old stick nests of other bird species

Northern Beardless-Tyrannulet	*Camptostoma imberbe*		T

mesquite woodlands; near Rio Grande frequents cottonwood, willow, elm, and great leadtree; breeding April to July

Peregrine Falcon	*Falco peregrinus*	DL	T

both subspecies migrate across the state from more northern breeding areas in US and Canada to winter along coast and farther south; subspecies (F. p. anatum) is also a resident breeder in west Texas; the two subspecies' listing statuses differ, F.p. tundrius is no longer listed in Texas; but because the subspecies are not easily distinguishable at a distance, reference is generally made only to the species level; see subspecies for habitat.

Piping Plover	*Charadrius melodus*	LT	T

wintering migrant along the Texas Gulf Coast; beaches and bayside mud or salt flats

Red Knot	*Calidris canutus rufa*	T	

Red knots migrate long distances in flocks northward through the contiguous United States mainly April-June, southward July-October. A small plump-bodied, short-necked shorebird that in breeding plumage, typically held from May through August, is a distinctive and unique pottery orange color. Its bill is dark, straight and, relative to other shorebirds, short-to-medium in length. After molting in late summer, this species is in a drab gray-and-white non-breeding plumage, typically held from September through April. In the non-breeding plumage, the knot might be confused with the omnipresent Sanderling. During this plumage, look for the knot's prominent pale eyebrow and whitish flanks with dark barring. The Red Knot prefers the shoreline of coast and bays and also uses mudflats during rare inland encounters. Primary prey items include coquina clam (Donax spp.) on beaches and dwarf surf clam (Mulinia lateralis) in bays, at least in the Laguna Madre. Wintering Range includes- Aransas, Brazoria, Calhoun, Cameron, Chambers, Galveston, Jefferson, Kennedy, Kleberg, Matagorda, Nueces, San Patricio, and Willacy. Habitat: Primarily seacoasts on tidal flats and beaches, herbaceous wetland, and Tidal flat/shore.

Reddish Egret	*Egretta rufescens*		T

resident of the Texas Gulf Coast; brackish marshes and shallow salt ponds and tidal flats; nests on ground or in trees or bushes, on dry coastal islands in brushy thickets of yucca and prickly pear

Rose-throated Becard	*Pachyramphus aglaiae*		T

riparian trees, woodlands, open forest, scrub, and mangroves; breeding April to July

WILLACY COUNTY

BIRDS		Federal Status	State Status
Sennett's Hooded Oriole	*Icterus cucullatus sennetti*		

often builds nests in and of Spanish moss (Tillandsia unioides); feeds on invertebrates, fruit, and nectar; breeding March to August

Snowy Plover	*Charadrius alexandrinus*		

formerly an uncommon breeder in the Panhandle; potential migrant; winter along coast

Sooty Tern	*Sterna fuscata*		T

predominately 'on the wing'; does not dive, but snatches small fish and squid with bill as it flies or hovers over water; breeding April-July

Sprague's Pipit	*Anthus spragueii*		

only in Texas during migration and winter, mid September to early April; short to medium distance, diurnal migrant; strongly tied to native upland prairie, can be locally common in coastal grasslands, uncommon to rare further west; sensitive to patch size and avoids edges.

Texas Botteri's Sparrow	*Aimophila botterii texana*		T

grassland and short-grass plains with scattered bushes or shrubs, sagebrush, mesquite, or yucca; nests on ground of low clump of grasses

Tropical Parula	*Parula pitiayumi*		T

dense or open woods, undergrowth, brush, and trees along edges of rivers and resacas; breeding April to July

Western Burrowing Owl	*Athene cunicularia hypugaea*		

open grasslands, especially prairie, plains, and savanna, sometimes in open areas such as vacant lots near human habitation or airports; nests and roosts in abandoned burrows

Western Snowy Plover	*Charadrius alexandrinus nivosus*		

uncommon breeder in the Panhandle; potential migrant; winter along coast

White-faced Ibis	*Plegadis chihi*		T

prefers freshwater marshes, sloughs, and irrigated rice fields, but will attend brackish and saltwater habitats; nests in marshes, in low trees, on the ground in bulrushes or reeds, or on floating mats

White-tailed Hawk	*Buteo albicaudatus*		T

near coast on prairies, cordgrass flats, and scrub-live oak; further inland on prairies, mesquite and oak savannas, and mixed savanna-chaparral; breeding March-May

Wood Stork	*Mycteria americana*		T

forages in prairie ponds, flooded pastures or fields, ditches, and other shallow standing water, including salt-water; usually roosts communally in tall snags, sometimes in association with other wading birds (i.e. active heronries); breeds in Mexico and birds move into Gulf States in search of mud flats and other wetlands, even those associated with forested areas; formerly nested in Texas, but no breeding records since 1960

WILLACY COUNTY

	BIRDS	Federal Status	State Status
Zone-tailed Hawk	*Buteo albonotatus*		T

arid open country, including open deciduous or pine-oak woodland, mesa or mountain county, often near watercourses, and wooded canyons and tree-lined rivers along middle-slopes of desert mountains; nests in various habitats and sites, ranging from small trees in lower desert, giant cottonwoods in riparian areas, to mature conifers in high mountain regions

	FISHES	Federal Status	State Status
American eel	*Anguilla rostrata*		

coastal waterways below reservoirs to gulf; spawns January to February in ocean, larva move to coastal waters, metamorphose, then females move into freshwater; most aquatic habitats with access to ocean, muddy bottoms, still waters, large streams, lakes; can travel overland in wet areas; males in brackish estuaries; diet varies widely, geographically, and seasonally

Opossum pipefish	*Microphis brachyurus*		T

brooding adults found in fresh or low salinity waters and young move or are carried into more saline waters after birth; southern coastal areas

Smalltooth sawfish	*Pristis pectinata*	LE	E

different life history stages have different patterns of habitat use; young found very close to shore in muddy and sandy bottoms, seldom descending to depths greater than 32 ft (10 m); in sheltered bays, on shallow banks, and in estuaries or river mouths; adult sawfish are encountered in various habitat types (mangrove, reef, seagrass, and coral), in varying salinity regimes and temperatures, and at various water depths, feed on a variety of fish species and crustaceans

	INSECTS	Federal Status	State Status
A tiger beetle	*Tetracha affinis angustata*		

most tiger beetles diurnal, open sandy areas, beaches, open paths or lanes, or on mudflats; larvae in hard-packed ground in vertical burrows

Los Olmos tiger beetle	*Cicindela nevadica olmosa*		

most tiger beetles are active, usually brightly colored, and found in open, sunny areas; adult tiger beetles are predaceous and feed on a variety of small insects; larvae of tiger beetles are also predaceous and live in vertical burrows in soil of dry paths, fields, or sandy beaches

Superb grasshopper	*Eximacris superbum*		

collected in south Texas, but repeated efforts to collect not successful; may over-winter in adult stage

	MAMMALS	Federal Status	State Status
Coues' rice rat	*Oryzomys couesi*		T

cattail-bulrush marsh with shallower zone of aquatic grasses near the shoreline; shade trees around the shoreline are important features; prefers salt and freshwater, as well as grassy areas near water; breeds April-August

WILLACY COUNTY

MAMMALS

		Federal Status	State Status
Jaguar	*Panthera onca*	LE	E

extirpated; dense chaparral; no reliable TX sightings since 1952

Jaguarundi	*Herpailurus yaguarondi*	LE	E

thick brushlands, near water favored; 60 to 75 day gestation, young born sometimes twice per year in March and August, elsewhere the beginning of the rainy season and end of the dry season

Mexican long-tongued bat	*Choeronycteris mexicana*		

deep canyons where uses caves and mine tunnels as day roosts; also found in buildings and often associated with big-eared bats (Plecotus spp.); single TX record from Santa Ana NWR

Ocelot	*Leopardus pardalis*	LE	E

dense chaparral thickets; mesquite-thorn scrub and live oak mottes; avoids open areas; breeds and raises young June-November

Plains spotted skunk	*Spilogale putorius interrupta*		

catholic; open fields, prairies, croplands, fence rows, farmyards, forest edges, and woodlands; prefers wooded, brushy areas and tallgrass prairie

Southern yellow bat	*Lasiurus ega*		T

associated with trees, such as palm trees (Sabal mexicana) in Brownsville, which provide them with daytime roosts; insectivorous; breeding in late winter

West Indian manatee	*Trichechus manatus*	LE	E

Gulf and bay system; opportunistic, aquatic herbivore

White-nosed coati	*Nasua narica*		T

woodlands, riparian corridors and canyons; most individuals in Texas probably transients from Mexico; diurnal and crepuscular; very sociable; forages on ground and in trees; omnivorous; may be susceptible to hunting, trapping, and pet trade

REPTILES

		Federal Status	State Status
Atlantic hawksbill sea turtle	*Eretmochelys imbricata*	LE	E

Gulf and bay system, warm shallow waters especially in rocky marine environments, such as coral reefs and jetties, juveniles found in floating mats of sea plants; feed on sponges, jellyfish, sea urchins, molluscs, and crustaceans, nests April through November

Black-striped snake	*Coniophanes imperialis*		T

extreme south Texas; semi-arid coastal plain, warm, moist micro-habitats and sandy soils; proficient burrower; eggs laid April-June

Green sea turtle	*Chelonia mydas*	LT	T

Gulf and bay system; shallow water seagrass beds, open water between feeding and nesting areas, barrier island beaches; adults are herbivorous feeding on sea grass and seaweed; juveniles are omnivorous feeding initially on marine invertebrates, then increasingly on sea grasses and seaweeds; nesting behavior extends from March to October, with peak activity in May and June

WILLACY COUNTY

REPTILES		Federal Status	State Status
Keeled earless lizard	*Holbrookia propinqua*		

coastal dunes, barrier islands, and other sandy areas; eats insects and likely other small invertebrates; eggs laid underground March-September (most May-August)

Kemp's Ridley sea turtle	*Lepidochelys kempii*	LE	E

Gulf and bay system, adults stay within the shallow waters of the Gulf of Mexico; feed primarily on crabs, but also snails, clams, other crustaceans and plants, juveniles feed on sargassum and its associated fauna; nests April through August

Leatherback sea turtle	*Dermochelys coriacea*	LE	E

Gulf and bay systems, and widest ranging open water reptile; omnivorous, shows a preference for jellyfish; in the US portion of their western Atlantic nesting territories, nesting season ranges from March to August

Loggerhead sea turtle	*Caretta caretta*	LT	T

Gulf and bay system primarily for juveniles, adults are most pelagic of the sea turtles; omnivorous, shows a preference for mollusks, crustaceans, and coral; nests from April through November

Northern cat-eyed snake	*Leptodeira septentrionalis septentrionalis*		T

Gulf Coastal Plain south of the Nueces River; thorn brush woodland; dense thickets bordering ponds and streams; semi-arboreal; nocturnal

Speckled racer	*Drymobius margaritiferus*		T

extreme south Texas; dense thickets near water, Texas palm groves, riparian woodlands; often in areas with much vegetation litter on ground; breeds April-August

Spot-tailed earless lizard	*Holbrookia lacerata*		

central and southern Texas and adjacent Mexico; moderately open prairie-brushland; fairly flat areas free of vegetation or other obstructions, including disturbed areas; eats small invertebrates; eggs laid underground

Texas horned lizard	*Phrynosoma cornutum*		T

open, arid and semi-arid regions with sparse vegetation, including grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive; breeds March-September

Texas indigo snake	*Drymarchon melanurus erebennus*		T

Texas south of the Guadalupe River and Balcones Escarpment; thornbush-chaparral woodlands of south Texas, in particular dense riparian corridors; can do well in suburban and irrigated croplands if not molested or indirectly poisoned; requires moist microhabitats, such as rodent burrows, for shelter

Texas scarlet snake	*Cemophora coccinea lineri*		T

mixed hardwood scrub on sandy soils; feeds on reptile eggs; semi-fossorial; active April-September

Texas tortoise	*Gopherus berlandieri*		T

open brush with a grass understory is preferred; open grass and bare ground are avoided; when inactive occupies shallow depressions at base of bush or cactus, sometimes in underground burrows or under objects; longevity greater than 50 years; active March-November; breeds April-November

WILLACY COUNTY

PLANTS

		Federal Status	State Status
Bailey's ballmoss	*Tillandsia baileyi*		

epiphytic on various trees and tall shrubs, perhaps most common in mottes of Live oak on vegtated dunes and flats in coastal portions of the South Texas Sand Sheet, but also on evergreen sub-tropical woodlands along resacas in the Lower Rio Grande Valley; flowering (February-)April-May, but conspicuous throughout the year

Cory's croton *Croton coryi*

GLOBAL RANK: G3; Grasslands and woodland openings on barrier islands and coastal sands of South Texas, inland on South Texas Sand Sheet; Annual; Flowering July-Oct; Fruiting July-Nov

Runyon's water-willow *Justicia runyonii*

margins of and openings within subtropical woodlands or thorn shrublands on calcareous, alluvial, silty or clayey soils derived from Holocene silt and sand floodplain deposits of the Rio Grande Delta; can be common in narow openings such as those provided by trails through dense ebony woodlands and is sometimes restricted to microdepressions; flowering (July-) September-November

Small-leaved yellow velvet-leaf *Wissadula parvifolia*

Occurs on sandy loams or clays in shrublands or woodlands on gently undulating terrain of the Holocene sand sheet over the Goliad Formation.

Texas ayenia *Ayenia limitaris* LE E

Subtropical thorn woodland or tall shrubland on loamy soils of the Rio Grande Delta; known site soils include well-drained, calcareous, sandy clay loam (Hidalgo Series) and neutral to moderately alkaline, fine sandy loam (Willacy Series); also under or among taller shrubs in thorn woodland/thorn shrubland; flowering throughout the year with sufficient rainfall

Vasey's adelia *Adelia vaseyi*

Mostly subtropical evergreen/deciduous woodlands on loamy soils of Rio Grande Delta, but occassionally in shrublands on more xeric sandy to gravelly upland sites; Perennial; Flowering January-June

Velvet spurge *Euphorbia innocua*

GLOBAL RANK: G3; Open or brushy areas on coastal sands and the South Texas Sand Sheet; Perennial; Flowering Sept-April; Fruiting Nov-July

Wright's trichocoronis *Trichocoronis wrightii var. wrightii*

GLOBAL RANK: G4T3; Most records from Texas are historical, perhaps indicating a decline as a result of alteration of wetland habitats; Annual; Flowering Feb-Oct; Fruiting Feb-Sept

ZAPATA COUNTY

AMPHIBIANS

		Federal Status	State Status
Mexican burrowing toad	*Rhinophrynus dorsalis*		T

roadside ditches, temporary ponds, arroyos, or wherever loose friable soils are present in which to burrow; generally underground emerging only to breed or during rainy periods

White-lipped frog	*Leptodactylus fragilis*		T

grasslands, cultivated fields, roadside ditches, and a wide variety of other habitats; often hides under rocks or in burrows under clumps of grass; species requirements incompatible with widespread habitat alteration and pesticide use in south Texas

BIRDS

		Federal Status	State Status
American Peregrine Falcon	*Falco peregrinus anatum*	DL	T

year-round resident and local breeder in west Texas, nests in tall cliff eyries; also, migrant across state from more northern breeding areas in US and Canada, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.

Arctic Peregrine Falcon	*Falco peregrinus tundrius*	DL	

migrant throughout state from subspecies' far northern breeding range, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.

Audubon's Oriole	*Icterus graduacauda audubonii*		

scrub, mesquite; nests in dense trees, or thickets, usually along water courses

Baird's Sparrow	*Ammodramus bairdii*		

shortgrass prairie with scattered low bushes and matted vegetation; mostly migratory in western half of State, though winters in Mexico and just across Rio Grande into Texas from Brewster through Hudspeth counties

Cactus Ferruginous Pygmy-Owl	*Glaucidium brasilianum cactorum*		T

riparian trees, brush, palm, and mesquite thickets; during day also roosts in small caves and recesses on slopes of low hills; breeding April to June

Common Black-Hawk	*Buteogallus anthracinus*		T

cottonwood-lined rivers and streams; willow tree groves on the lower Rio Grande floodplain; formerly bred in south Texas

Gray Hawk	*Asturina nitida*		T

locally and irregularly along U.S.-Mexico border; mature riparian woodlands and nearby semiarid mesquite and scrub grasslands; breeding range formerly extended north to southernmost Rio Grande floodplain of Texas

ZAPATA COUNTY

BIRDS		Federal Status	State Status
Hook-billed Kite	*Chondrohierax uncinatus*		

dense tropical and subtropical forests, but does occur in open woodlands; uncommon to rare in most of range; accidental in south Texas

Interior Least Tern	*Sterna antillarum athalassos*	LE	E

subspecies is listed only when inland (more than 50 miles from a coastline); nests along sand and gravel bars within braided streams, rivers; also know to nest on man-made structures (inland beaches, wastewater treatment plants, gravel mines, etc); eats small fish and crustaceans, when breeding forages within a few hundred feet of colony

Mexican Hooded Oriole	*Icterus cucullatus cucullatus*		

scrub, mesquite; nests in dense trees, or thickets, usually along water courses

Northern Beardless-Tyrannulet	*Camptostoma imberbe*		T

mesquite woodlands; near Rio Grande frequents cottonwood, willow, elm, and great leadtree; breeding April to July

Peregrine Falcon	*Falco peregrinus*	DL	T

both subspecies migrate across the state from more northern breeding areas in US and Canada to winter along coast and farther south; subspecies (F. p. anatum) is also a resident breeder in west Texas; the two subspecies' listing statuses differ, F.p. tundrius is no longer listed in Texas; but because the subspecies are not easily distinguishable at a distance, reference is generally made only to the species level; see subspecies for habitat.

Sennett's Hooded Oriole	*Icterus cucullatus sennetti*		

often builds nests in and of Spanish moss (Tillandsia unioides); feeds on invertebrates, fruit, and nectar; breeding March to August

Sprague's Pipit	*Anthus spragueii*		

only in Texas during migration and winter, mid September to early April; short to medium distance, diurnal migrant; strongly tied to native upland prairie, can be locally common in coastal grasslands, uncommon to rare further west; sensitive to patch size and avoids edges.

Western Burrowing Owl	*Athene cunicularia hypugaea*		

open grasslands, especially prairie, plains, and savanna, sometimes in open areas such as vacant lots near human habitation or airports; nests and roosts in abandoned burrows

Wood Stork	*Mycteria americana*		T

forages in prairie ponds, flooded pastures or fields, ditches, and other shallow standing water, including salt-water; usually roosts communally in tall snags, sometimes in association with other wading birds (i.e. active heronries); breeds in Mexico and birds move into Gulf States in search of mud flats and other wetlands, even those associated with forested areas; formerly nested in Texas, but no breeding records since 1960

ZAPATA COUNTY

FISHES — Federal Status / State Status

Rio Grande shiner *Notropis jemezanus*

Rio Grande and upper Pecos River basins; large, open, weedless rivers or large creeks with bottom of rubble, gravel and sand, often overlain with silt

Rio Grande silvery minnow *Hybognathus amarus* — Federal: LE — State: E

extirpated; historically Rio Grande and Pecos River systems and canals; reintroduced in Big Bend area; pools and backwaters of medium to large streams with low or moderate gradient in mud, sand, or gravel bottom; ingests mud and bottom ooze for algae and other organic matter; probably spawns on silt substrates of quiet coves

INSECTS — Federal Status / State Status

Neojuvenile tiger beetle *Cicindela obsoleta neojuvenilis*

bare or sparsely vegetated, dry, hard-packed soil; typically in previously disturbed areas; peak adult activity in Jul

MAMMALS — Federal Status / State Status

Black bear *Ursus americanus* — State: T

bottomland hardwoods and large tracts of inaccessible forested areas

Cave myotis bat *Myotis velifer*

colonial and cave-dwelling; also roosts in rock crevices, old buildings, carports, under bridges, and even in abandoned Cliff Swallow (Hirundo pyrrhonota) nests; roosts in clusters of up to thousands of individuals; hibernates in limestone caves of Edwards Plateau and gypsum cave of Panhandle during winter; opportunistic insectivore

Davis pocket gopher *Geomys personatus davisi*

burrows in sandy soils in southern Texas

Jaguarundi *Herpailurus yaguarondi* — Federal: LE — State: E

thick brushlands, near water favored; 60 to 75 day gestation, young born sometimes twice per year in March and August, elsewhere the beginning of the rainy season and end of the dry season

Ocelot *Leopardus pardalis* — Federal: LE — State: E

dense chaparral thickets; mesquite-thorn scrub and live oak mottes; avoids open areas; breeds and raises young June-November

Plains spotted skunk *Spilogale putorius interrupta*

catholic; open fields, prairies, croplands, fence rows, farmyards, forest edges, and woodlands; prefers wooded, brushy areas and tallgrass prairie

White-nosed coati *Nasua narica* — State: T

ZAPATA COUNTY

MAMMALS		Federal Status	State Status

woodlands, riparian corridors and canyons; most individuals in Texas probably transients from Mexico; diurnal and crepuscular; very sociable; forages on ground and in trees; omnivorous; may be susceptible to hunting, trapping, and pet trade

MOLLUSKS		Federal Status	State Status
Mexican fawnsfoot mussel	*Truncilla cognata*		T

largely unknown; possibly intolerant of impoundment; possibly needs flowing streams and rivers with sand or gravel bottoms based on related species needs; Rio Grande basin

Salina mucket	*Potamilus metnecktayi*		T

lotic waters; submerged soft sediment (clay and silt) along river bank; other habitat requirements are poorly understood; Rio Grande Basin

Texas hornshell	*Popenaias popeii*	C	T

both ends of narrow shallow runs over bedrock, in areas where small-grained materials collect in crevices, along river banks, and at the base of boulders; not known from impoundments; Rio Grande Basin and several rivers in Mexico

REPTILES		Federal Status	State Status
Reticulate collared lizard	*Crotaphytus reticulatus*		T

requires open brush-grasslands; thorn-scrub vegetation, usually on well-drained rolling terrain of shallow gravel, caliche, or sandy soils; often on scattered flat rocks below escarpments or isolated rock outcrops among scattered clumps of prickly pear and mesquite

Spot-tailed earless lizard	*Holbrookia lacerata*		

central and southern Texas and adjacent Mexico; moderately open prairie-brushland; fairly flat areas free of vegetation or other obstructions, including disturbed areas; eats small invertebrates; eggs laid underground

Texas horned lizard	*Phrynosoma cornutum*		T

open, arid and semi-arid regions with sparse vegetation, including grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive; breeds March-September

Texas indigo snake	*Drymarchon melanurus erebennus*		T

Texas south of the Guadalupe River and Balcones Escarpment; thornbush-chaparral woodlands of south Texas, in particular dense riparian corridors; can do well in suburban and irrigated croplands if not molested or indirectly poisoned; requires moist microhabitats, such as rodent burrows, for shelter

Texas tortoise	*Gopherus berlandieri*		T

ZAPATA COUNTY

REPTILES — Federal Status — State Status

open brush with a grass understory is preferred; open grass and bare ground are avoided; when inactive occupies shallow depressions at base of bush or cactus, sometimes in underground burrows or under objects; longevity greater than 50 years; active March-November; breeds April-November

PLANTS — Federal Status — State Status

Arrowleaf milkvine *Matelea sagittifolia*

GLOBAL RANK: G3 ; Most consistently encountered in thornscrub in South Texas; Perennial; Flowering March-July; Fruiting April-July & Dec?

Ashy dogweed *Thymophylla tephroleuca* LE E

Texas endemic; grasslands with scattered shrubs; most sites on sands or sandy loams on level or very gently rolling topography over Eocene strata of the Laredo Formation; flowering March-May depending to some extent on rainfall

Burridge greenthread *Thelesperma burridgeanum*

GLOBAL RANK: G3; Sandy open areas; Annual; Flowering March-Nov; Fruiting March-June

Chihuahua balloon-vine *Cardiospermum dissectum*

Thorn shrublands or low woodlands on well to excessively well drained, calcareous, sandy to gravelly soils in drier uplands of the Lower Rio Grande Valley, in areas underlain by the Goliad formation, Catahoula and Frio formations undivided, Jackson Group, and other Eocene formations; during drought conditions the normally inconspicuous slender twining vine turns a more conspicuous deep reddish-purple; flowering (April-) July-September, probably throughout the growing season in response to rainfall.

Correll's bluet *Houstonia correllii*

Texas endemic; sandy soils in grasslands with scattered shrubs or in mesquite savannas; does not occur in disturbed sandy areas or in 'improved' pastures; flowering March, other months unknown

Correll's false dragon-head *Physostegia correllii*

wet, silty clay loams on streamsides, in creek beds, irrigation channels and roadside drainage ditches; or seepy, mucky, sometimes gravelly soils along riverbanks or small islands in the Rio Grande; or underlain by Austin Chalk limestone along gently flowing spring-fed creek in central Texas; flowering May-September

Fitch's hedgehog cactus *Echinocereus reichenbachii var. fitchii*

GLOBAL RANK: G5T3; Grasslands, thorn shrublands, and mesquite-acacia woodlands on sandy, possibly somewhat saline, soils on the coastal prairie. Within these communities, the plants may be most frequently found in open areas that are somewhat sparsely covered with brush of a low stature. Frequently grows at the ecotone where these upland areas meet lower areas dominated by halophytic grasses and forbs; Perennial

ZAPATA COUNTY

PLANTS

		Federal Status	State Status
Johnston's frankenia	*Frankenia johnstonii*	LE-PDL	E

dwarf shrublands on strongly saline, highly alkaline, calcareous or gypseous, clayey to sandy soils of valley flats or rocky slopes; mapped soils at many sites are of the Catarina and/or Maverick Series, other mapped soils include Copita, Brennan, Zapata, and Montell series; most sites are underlain by Eocene sandstones and clays of the Jackson Group or the Yegua and Laredo formations; a few are underlain by El Pico clay or the Catahoula and Frio formations shrublands; flowering throughout the growing season depending upon rainfall

Kleberg saltbush *Atriplex klebergorum*

Texas endemic; usually occurs in sparsely vegetated saline areas, including flats and draws; in light sandy or clayey loam soils with other halophytes; occasionally observed on scraped oil pad sites; observed flowering in late August-early September, but may vary with rainfall, fruits are usually present in fall; because of its annual nature, populations fluctuate widely from year to year

Prostrate milkweed *Asclepias prostrata*

grasslands or openings in shrublands on loamy fine sands and fine sandy loams of the Copita, Hebbronville, and possibly other soil series occurring over the Laredo, Yegua, and other Eocene formations; also in Loreto caliche sand plain in Tamaulipas; flowering April-October, but may be sporadic and dependent on rainfall

Sand sheet leaf-flower *Phyllanthus abnormis var. riograndensis*

GLOBAL RANK: G5T3; Semi-desert scrub of deep South Texas; Annual; Flowering Feb-July; Fruiting Oct-March

Shortcrown milkvine *Matelea brevicoronata*

GLOBAL RANK: G3; Primarily in grasslands on tight sandy or silty substrates; Perennial; Flowering March-Sept; Fruiting May-Sept

St. Joseph's staff *Manfreda longiflora*

thorn shrublands on clays and loams with various concentrations of salt, caliche, sand, and gravel; rossettes are often obscured by low shrubs; flowering September-October

Star cactus	*Astrophytum asterias*	LE	E

gravelly clays or loams, possibly of the Catarina Series (deep, droughty, saline clays), over the Catahoula and Frio formations, on gentle slopes and flats in sparsely vegetated openings between shrub thickets within mesquite grasslands or mesquite-blackbrush thorn shrublands; plants sink into or below ground during dry periods; flowering from mid March-May, may also flower in warmer months after sufficient rainfall, flowers most reliably in early April; fruiting mid April-June

Stinking rushpea *Pomaria austrotexana*

GLOBAL RANK: G3; In open areas on deep well drained sands; Perennial; Flowering Feb-Oct; Fruiting April-Oct

ZAPATA COUNTY

	PLANTS	Federal Status	State Status
Zapata bladderpod	*Physaria thamnophila*	LE	E

open, thorn shrublands on shallow, well-drained sandy loams and sandstone outcrops of Eocene origin, including the Jackson Group and Yegua and Laredo formations; the known sites' soils are mapped as Zapata, Maverick, Catarina, or Copita Series; flowering usually February-April, but also summer or fall depending on rainfall

Gulf Coast Citrus Greening Quarantine

Harris, Fort Bend, and Montgomery counties are under a citrus greening **quarantine** to slow the spread of the disease. Citrus plants cannot be moved out of the quarantined counties.

What is citrus greening?

Citrus greening (CG), a bacterial disease that infects citrus, ornamentals, and herbal plants such as orange jasmine and curry plant, is spread by an insect, the Asian citrus psyllid (ACP). It is also known as Huanglongbing or yellow dragon disease. There is no cure for CG. The disease exists throughout the world and was first found in Texas in 2012.

What do I look for?

A tree infected by citrus greening may have:

Asian citrus psyllid

- Adult is about the size of a toothpick tip (about 3mm) and has a distinctive 45-degree angled posture when present on leaves.
- Nymphs are smaller and yellow-orange. They feed on new growth and secrete a waxy substance (red arrows).

Photo credit: N.Hummel, LSU AgCenter, bugwood.org

Leaves and branches

- Leaves are blotchy, mottled, and yellowed.
- Leaves may have raised veins with a corky appearance.

Fruit

- Fruit tastes bitter but poses no health problems to humans.
- Fruit may be stunted or lopsided, remain green or partially green, and fall prematurely from the tree.

Examples of abnormal fruit found in Florida.

To learn more about citrus greening disease, visit http://texascitrusgreening.org, http://bit.ly/CGinfo, or http://citrusalert.com, or http://AgriLifeBookstore.org.

Texas A&M AgriLife Extension

TNLA Texas Nursery & Landscape Association

Department of Agriculture • Texas •

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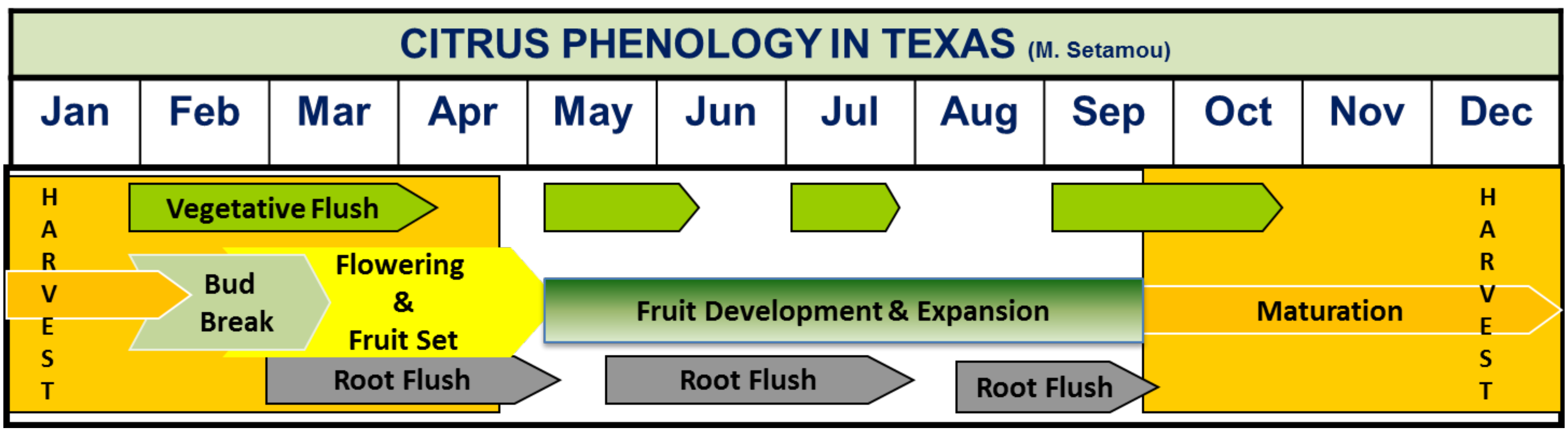
Bee protection strategy

In Texas, we have put in place a proactive good pesticide stewardship program not only to mitigate possible pest resistance development to neonicotinoids, but also to protect bees. Our bloom period occurs between from mid-February to April. As a strategy, we do not recommend application of neonicotinoid-based insecticide is sprayed from January to April every year. Young trees (in nurseries and newly established groves) **DO NOT** bloom until they are 3 to four years-old. Thus, growers can effectively use neonicotinoids in nurseries and newly established groves without the risk of bee exposure to these insecticides year round. Whenever, tree start blooming, soil-drench applications of these materials are seldom done, and if they occur they start in April based on our recommendations. Texas citrus growers are educated to avoid spraying any insecticides containing neonicotinoid-based materials from January to early April. Given the fact that low psyllid populations do not occur during that time (as a result of winter and coordinated dormant sprays); growers refrain from using their best insecticides (i.e. neonicotinoids) during that time. Instead, they use neonicotinoid-based materials when psyllid populations are high (May to October).

Citrus phenology in Texas

Citrus bloom period goes from mid-February to April every year. Typically, grapefruit will bloom over a 4 to 5 a weeks-period, while orange will bloom for a 4 to 6 weeks-period (See attached for Citrus phenology in Texas).

Citrus Phenology in Texas



Note: Trees are typically found flowering (blooming) from mid-February to April.